TELEPHONE ENGINEER

Volume 30 APRIL, 1926 Number 4

BELL LICENSE CHARGE REDUCTION

When a manufacturer announces a reduction in the selling prices of his product, or a retail merchant advertises a lower resale price for various articles or a bank offers an additional half of one per cent on time deposits, the people affected by the change ordinarily assume that there were good business reasons for doing it, perhaps congratulate themselves on being able to profit by it and go little further in speculation as to the exact reasons for the change.

When a concern of the magnitude of the American Telephone and Telegraph Company announces a change in the terms of its license contracts, particularly in a matter of so many years' standing and one which has been the subject of so much acrid controversy as the four and one-half per cent charge, there is naturally much curiosity in the industry and among regulatory bodies as to the reasons behind the change.

In the former situation, an explanation that "it's good business" would be accepted as a satisfactory explanation and there would be assumed any one or several of a number of good reasons, such as a desire to increase the volume of business or to pass on to consumers savings which may have been made in production. In the latter case, the unofficial explanation "it's good business" is likely to be interpreted by some, particularly by professional utility baiters, as having behind it an ulterior motive of some kind.

By some, the change may be interpreted as an admission that the parent company has been overcharging for services through all of the years since 1902 when the charge was first placed in effect. By others, it may be construed as a weakening on the part of Bell officials in the face of continued attacks before public service commissions. A few suspicious ones may even fear that the concession made in this will be more than made up by other exactions which do not come into the public eye.

It seems scarcely necessary to look for any such forced explanations, however. During the past six years, the net earnings of the over $2.00 per share in excess of dividend requirements and the dividend rate has been placed at a figure that is sufficiently attractive that all stock offerings have been oversubscribed. It would seem that the natural thing is to pass back in the form of a reduced charge to the operating companies some of the prosperity of the parent company.

While Bell officials have always strongly defended the justice of the four and one-half per cent charge, they have never contended that it is the ideal way to apportion the expenses which are of undoubted benefit to the entire system. In fact, Mr. H. B. Thayer, former president and now chairman of the board of directors, in an address before the Association of Railway and Utility Commissioners a few years ago, stated that from time to time studies had been made of the cost of the service and the methods of payment but that no one had been able to suggest a better or fairer way than the percentage charge.

It is not the way of the Bell system to take for granted that a problem is insoluble because the solution is not apparent. Many things regarded as impossible only a short time ago are now working realities. Perhaps something of the same kind is happening here. The formation of Bell Laboratories, Inc., in the ownership of which the manufacturing branch participates may indicate that a way has been found to spread certain of the development costs of equipment over the apparatus that reaches the stage of commercial production, just as is done in other manufacturing lines. It is not beyond bounds of possibility that the policy of leasing transmitters, receivers and coils may be abandoned at some future time and this equipment purchased outright by the operating companies thus eliminating much troublesome special accounting. It may be possible that a way will be found to charge directly for certain other specific services.

There will always be an irreducible minimum of general legal, accounting, engineering and financial services that cannot be charged specifically and it does not seem likely that the percentage charge will disappear entirely, but it is not impossible that further reductions may be made.

The old adage of looking the gift horse in the mouth is not entirely inapplicable here and those in the industry and outside may rejoice that the Bell system has found that "it's good business" to reduce the amount of the

charge even if good business does not require a detailed explanation of why it was done.

SELLING SERVICE WHERE FACILITIES EXIST

It does not need argument to prove that the most profitable plant is the one that is using its facilities up to the economic limit. This does not mean that a plant is the most profitable when every cable pair is filled and every pin space is full. There is a point—perhaps somewhere between eighty and ninety percent of saturation—where new subscribers can still be taken on without undue cost per station gained and yet the idle plant does not create an excessive fixed charge on nonproductive investment.

It would be the ideal situation if our plants could always be operated at this point. What we actually find is that certain portions of the plant are worked above the economic limit and other portions have an excessive amount of spare facilities.

It should be the object of the commercial department of every telephone company to make the existing plant produce the maximum possible revenue and here is the opportunity to exercise the art of salesmanship to bring up the revenue of the portion of the plant where spare facilities exist. In nearly every community there are still people who could use telephone service to advantage, but who do not have it. There are others who could use additional lines. There are party line subscribers who could be sold on higher grades of service.

Even if no organized canvassing is undertaken, there is always an opportunity in connection with the moves and installations that are constantly taking place. A large class of subscribers are in the border line class who can be sold either individual line service or party line service depending upon the manner in which the matter is presented by the commercial representative of the telephone company. If these employees who handle contracts are furnished with the proper information as to the rates of growth in various parts of the plant and the facilities in existence they can do much to improve the earning capacity of the plant by selling the class of service that will make the best economic use of the facilities available.

THE A. T. & T. REPORT

As important a document as the annual report of the American Telephone and Telegraph Company always compels attention and merits discussion. The report for 1925, like those of other years, is rather an exhaustive survey of conditions in the Bell system and therefore of the industry as a whole because all companies are more or less affected by the conditions that affect the Bell companies.

The general impression left by a reading of the report is that the Bell system is now in the most favorable position, generally speaking, that it has ever reached. Its earnings are being maintained at a satisfactory level, the greater part of its rate adjustments made necessary by changing monetary values are completed and it has nearly reached the place where a normal excess of plant over actual requirements is available.

While extensions continue to be large, they are only the extensions required by growth and improvement of the service and the strong financial position of the parent company makes the securing of funds comparatively easy. In the main, its public relations are good and its personnel policy has borne fruit in the development of a loyal and efficient force of employees.

As the report states, it is probable that the business is less hazardous to manage than ever before because it is possible to plan deliberately and to budget operations for years in advance. This fortunate situation has made it possible to give intensive study to the improvement of both quality and quantity of service and to proceed with experimental work looking toward greater, better and more economical telephone service.

Altogether, the report indicates that the telephone industry has reached an enviable position among the business enterprises of the country and can look forward to many years of prosperity and increasing usefulness.

TELEPHONE ENGINEER
28 E. Jackson Blvd., Chicago
Vol. 30. April
No. 4. 1926.
Entered as second-class matter, June 6, 1922, at the post office at Chicago, Ill., under the act of March 3, 1879.

SUBSCRIPTIONS
The subscription price of TELEPHONE ENGINEER is $2 a year in the United States, Cuba and Mexico; in Canada it is $3; in all other countries $4. Single copies, U. S. A., 20 cents.

ADVERTISING
TELEPHONE ENGINEER is issued the 15th of each month. Copy can be accepted as late as the 8th of the month preceding date of publication. Where proof must be seen, allow ample time for transmission in the mails. Display Advertising — Rates on application. Classified Advertising—"Wants," "For Sales," etc.—$4 an inch, or 7 cents a word per insertion.

TELL YOUR EDITOR ABOUT IT

Now that the construction season is beginning, it may not be amiss again to call attention to the fact that the editors of local newspapers are always glad to receive well written news stories describing the work which telephone companies are doing in their communities. The stringing of a new copper toll circuit or any other important work does not look different to the ordinary individual than the addition of a subscriber line and unless the work is called to the attention of the editor by the telephone company, he is likely to overlook it.

"But I am no writer," the usual telephone manager will object. To him we can say, "Try it. It's easier than it looks. If you can tell it you can write it." The securing of proper publicity is just as much a part of good management as is any other function.

Telephone Mathematics and Physics

By F. J. DOMMERQUE,
Fellow A. I. E. E.

1. Introduction

The most brilliantly written description of the Niagara Falls or any other wonder of nature, or of any object of art or industry, can never give as clear and complete a conception as a photograph or a painting. Unfortunately the physical phenomena which underlie the daily occupations of technical men in general and of the telephone man in particular, cannot be photographed or painted, because they have no body, they are simply processes and laws. However, they may be clad in mathematical formulae and illustrated by curves and in circuits, all of which comes very near to being a photograph or image of their invisible substance.

Only recently (in the February TELEPHONE ENGINEER) Mr. Higgins described lucidly the nature of phantom circuits and said toward the end of his article: "For those who care to study formulae the following may be interesting: The reactance of a circuit containing inductance is represented by the formula $2 \pi f L$ where π is a constant, etc." There must be many telephone men who not only care but desire to study formulae, but are not equipped with the necessary training and cannot devote the time nor have the inclination to wade through books and papers to pick out the matter of value in telephone technique.

An attempt will be made to present the elementary conception of mathematics and physics applied in telephone work, in such a manner that any one without a high school or college education will be able to prepare himself sufficiently for the comprehension of the general run of mathematics and physics encountered in the current literature on telephone subjects. The method of explanation chosen for this purpose is perhaps not so much methodical as it is practical, and most of all illustrative.

Mathematics are the handmaiden of physics; every mathematical formula has a physical meaning; it either serves as a tool to "get at" some physical phenomenon or law, or it furnishes a concise and general statement of a physical law which could not be expressed as briefly and generally in words.

Physical science occupies itself with the study, definition and explanation of processes and applications of natural phenomena and recording same for everybody's convenience and use. Frequently such a record is made easier understandable by illustrations or by what may be termed shorthand reproduction of the process in the form of circuits. All this will be discussed.

The reader will find now and then that the absolutely necessary measure of information has been exceeded by adding something which is interesting from a scientific and educational standpoint. The addition is made because it contributes to the stock of general knowledge, and besides it may come handy at some future reading; moreover students differ in mental equipment, nature has gifted some more than others, and what may be ballast to the one may be impulse to the other. Therefore the limits of information will not be drawn too close. There will also be numerous subjects with which the reader is already familiar, but, as it is desired to benefit all, the selection goes back to the most elementary subjects and leaves it to the advanced reader to skip judiciously. The start will be made with information of a general character to lay a foundation for the subsequent specialization on telephone subjects proper. The first study will take up the use of, and the operations with, decimals, and the metric system as embodied in the system of absolute units.

2. Decimals

In writing mathematical formulae the ordinary fractions are hardly ever used. In their place are found the decimal fractions, which follow the following rules: Arranging the sequence of numbers on a decimal basis, the natural row of 0 to 9, 10 to 99, 100 to 999 and so on, is obtained. Dividing each unit by 10, 100, 1,000 and so on, that is, by any number which is a multiple of 10, a decimal fraction is obtained. Instead of writing such fractions by the symbols $\frac{1}{10}, \frac{2}{10}, \frac{3}{10}$ to $\frac{9}{10}$, a decimal point is placed in front of the integer number, thus: .1, .2, .3 and so on to .9; next follows 1 and then 1.1, 1.2, 1.3 and so on. All those less than 1 are frequently written as 0.1, 0.2, 0.3 and so on, for sake of uniformity.

For $\frac{543}{10}$ we write 54.3; for $\frac{543}{100}$ we write 5.43; for $\frac{543}{1000}$ we write 0.543; for $\frac{543}{10,000}$ we write 0.0543; for $\frac{543}{100,000}$ we write 0.00543 and so on.

Decimal fractions are added by placing them one below the other, so that the decimal points are in line vertically, then adding in the usual manner. The decimal point in the sum is placed in line with the decimal points of the numbers added. Here is an example:

```
  456.78
    3.1245
    0.002
  ------
  459.9065
```

When there are vacant decimal places at the end of some of the decimal fractions to be added, they are disregarded. They could be filled with zeros as the addition of a zero at the end of a decimal fraction will not alter its value. In subtracting decimal fractions, when there are more decimal places in the subtrahend (subtrahend is the number to be subtracted) than there are places in the minuend (minuend is the number to be subtracted from), then the zeros may be filled in or not. If they are not filled in, a zero is assumed to be in the vacant place. Subtraction is performed by also placing the numbers with their decimal points in line vertically, thus:

13.24	456.78	0.002
5.6767	0.002	456.78
7.5633	456.778	—456.778

Notice that in the third example the difference (the result of a subtraction is called the difference) is negative, because the minuend is less than the subtrahend, besides the subtraction in such a case being performed differently. In case where the minuend is less than the subtrahend, the latter is subtracted from the minuend by reversing the process; that is, by subtracting the minuend from the subtrahend and placing the negative sign before the difference.

It may be inserted here that the mathematical symbol for "greater than" is $>$, and for "less than" is $<$. So 456.78 is greater than 0.002 is briefly written as $456.78 > 0.002$, and 0.002 is less than 456.78 is briefly written as $0.002 < 456.78$.

Suppose we multiply $\frac{543}{100}$ by 10, then we obtain $\frac{5430}{100}$ or 54.3; if we multiply $\frac{543}{100}$ by 100, we obtain $\frac{54,300}{100}$ or 543. It

will be noticed that multiplying by 10 shifts the decimal point one place to the right. Hence the rule may be established that shifting the decimal point of a decimal fraction one, two, three or more places to the right means that the decimal fraction has been multiplied correspondingly by 10,100, 1000 and so on. From the preceding example where 5.43 was written for $\frac{543}{100}$, then 0.543 for $\frac{543}{1000}$, then 0.0543 for $\frac{543}{10{,}000}$ and so on, it follows that by moving the decimal point one, two three or more places to the left, the decimal fraction is divided correspondingly by 10, 100, 1000 and so on. The reader is advised to take paper and pencil and work out some examples for himself. However good a student thinks himself to be in "catching on," he ought to practice working out examples. One example worked out thoroughly is worth more than a hundred pages read superficially.

To the above mentioned two rules may be added a third one; namely, to multiply two or more decimal fractions proceed the same as with integer numbers, only when the multiplication is completed cut off from the obtained result as many places, by moving the decimal point from the end to the left, as there are decimal places in both fractions combined. Example: Multiply 0.543 by 34.5.

```
0.543
34.5
-----
 2715
 2172
 1629
-------
18.7335
```

The result is 18.7335, because there are 4 decimal places in 0.543 and 34.5, namely 5, 4 and 3 in the one, and 5 in the other.

The familiar way of transforming ordinary fractions into decimal fractions is to divide the nominator by the denominator, which would give, for instance, for ⅛ the decimal 0.125; and for ⅜ the decimal 0.375.

3. Rational or Irrational Numbers

Not every fractional number will give a decimal number with a final limit like above examples. Take for instance ⅓. Dividing numerator by denominator gives 0.3333 and more threes, in fact threes into infinity. The result is an *infinite* decimal. In this example, where the digit 3 repeats itself continuously, we term the decimal a *periodic* decimal. It is immaterial whether the period begins immediately after the decimal point or not. Nor does it matter how many digits are contained in the period. Thus the decimal fraction 0.53987987987..... would also be periodic. (Notice the dots written as continuation of the unfinished decimal; in mathematical writing an expression which is very long and where the part of principal value is contained in the first beginning, or as is the case in the above example, where the continuation would be a repetition of the whole first part or of a part of it, the continuation is indicated by dots as a sign that the remainder of the expression is either of the same form or can be neglected.)

An infinite decimal fraction obtained from, or corresponding to, an ordinary fraction, will sooner or later become periodic. A decimal fraction not being periodic can not be transformed into an ordinary fraction. Such a non-periodic decimal is the number π (Greek letter for "p"), which is 3.14159265....., designating half the circle of radius 1, which will be explained presently.

Any integral or fractional number and any finite or infinite periodic decimal fraction is called a *rational* number, because it is possible with their aid to obtain absolutely definite results. A decimal fraction which is infinite and not periodic is termed *irrational*.

We have given by now a number of mathematical terms and definitions, which may be useless to the reader; this has been done to provide him with a means of reference, for he may read the expressions in the technical press and may wish to know what they mean; then he can refer to above explanations. There is no need for him to burden his memory with keeping them in his mind. The number π is particularly mentioned, because it plays such an important role in physics and mathematics. The formulae containing π are without number and its value in solving problems or making statements has been recognized centuries ago. The reader may never use it, but if he wishes to know anything about mathematics, he must know at least what π means. To make matters a little more clear to him and deduce some valuable facts we advise him to do the following: Take a sheet of paper, say, ordinary letterhead size, and push a pin through its center into the table to hold it there. Then make a loop out of a piece of thin flexible string, the loop when straightened out to measure about 3 inches from end to end. Lay the loop with one end around the pin and place the point of a pencil into the other end. Swing the pencil in a circle around the pin and draw a circle on the paper, which will then have a diameter of 6 inches, in case the loop, that is the distance from pin to pencilpoint, was 3 inches long. This distance from pin to pencil, or from center of circle to circumference of circle, will be the same for every point on the circle. The mathematical term for this distance is "radius," if it is only one; that is, the singular is radius, the plural, that is, when there are more than one, is "radii" (from the Latin). Now take a number of pins, at least 12, the more the better, and plant them with approximately equal distances from each other around the circumference of the circle. Then take another string not so pliable and lay it around the pins until the two ends meet; at that point cut off the surplus string; then measure the length of the string and you will find that it measures approximately $18\frac{27}{32}$ inches. This is expressed in decimals as 18.84375 inches as can be found either by dividing 27 by 32, or more conveniently from tables of decimal equivalents such as are contained in many trade publications. We have said "it measures *approximately* $18\frac{27}{32}$ or 18.84375", because it is impossible to obtain the exact measure, as the exact measure is equal to the diameter multiplied by π. The diameter is twice the radius or 6" and π is 3.14159265 .....; whence the circumference should be 18.84955590 ..... inches. The more pins are placed around the circle, the better the string will hug it and the closer the length of the string will come to 6 times π. By all this the rule is proven that the circumference of a circle is twice the radius multiplied by π. This shows that π has some practical value. If, for instance, a lineman wishes to know the diameter of a pole at a certain point above the ground, he can take a string, lay it around the pole at the particular point, measure the length of the string that circles the pole, and divide by π.

But we have not yet shown how decimal fractions are divided. This will be done on an example. Suppose the lineman finds that the string encircling the pole at the particular height above ground measures 29¼". This is 29.25", which is to be divided by π or by 3.14159265 ..... This could not be done, as π is an infinite quantity; but for practical applications π is usually abbreviated by leaving off a number of digits or places; the more exact a result is required, the more places must be used. In the lineman's case, where pole measurements are never very close, taking the value of π as 3.14159, or still better as 3.1416 will be acceptable. We say 3.1416 because the two last digits 59 come so near to 60 that the value 3.1416 would be closer than 3.1415 omitting the 0 as superfluous. We thus have to divide 29.25 by 3.1416. This is done as follows: Write down $\frac{29.25}{3.1416}$; now move the decimal point in both numbers to the right until the divisor becomes an integer number, thus: $\frac{292500}{31416}$; as 29.25 contained only two decimal places and 3.1416 four, we had to add two zeros to make up for the

missing places. If we had, for instance, the fraction $\frac{29.25}{0.01416}$, the moving of the decimal point would transform this into $\frac{2925000}{1416}$. Returning again to our example, we then divide as ordinarily:

$$292500 : 31416 = 9.310 \ldots\ldots$$

272744

97560
94248

33120
31416

17040

292500 : 31416 gives 9 and a remainder; by placing an 0 at the end of the remainder each time, we can continue dividing and obtain as many decimal places as we like. In our example three is sufficient. Therefore the diameter of the pole at the desired point is 9.310 inches. This is as near as one needs to know, the dimensions of a pole are never perfect anyway. 9.310 inches is practically 9 5/16″.

4. Generalization of Symbols

In order to make statements or to give rules not only for certain definite numbers, but for any number whatever—that is, to make a statement in such a form that will hold good for, or may apply to, any number—one has recourse to the letters of the alphabet, a, b, c and so on. We will apply this to the rules we have found about the circle. But first we will modify the choice of letters insofar as physical quantities are concerned. It has become customary to express certain physical phenomena or objects for generalization as well as for distinction by certain letters, sometimes by the first letters of the name of the phenomenon or object, sometimes by capital letters, or in various ways; the same has been done in mathematical writing but not so much for distinction as for the sake of easier calculation. In the case of the circle the radius is, as a rule, designated by "r"; the diameter by "d"; whence the relations, deduced in the previous paragraph, can be stated generally as follows: The diameter of a circle is equal to $2r$, or shortly $d = 2r$; the circumference of a circle is equal to $d\pi$, or shortly $c = d\pi$, if we designate the circumference by c. This can also be written $c = 2r\pi$, as d equals $2r$. In mathematical formulae it is not necessary to place the multiplication sign between letters but only between figures, as omitting the $\times$ sign between letters, and also between letters and figures, would not cause errors or confusion. However, in formulae often a dot is used as a multiplication sign; it is then placed above the line, thus $2 \cdot r \cdot \pi$ may also be written as $2r\pi$.

While discussing the properties of the circle, another item of interest pertaining to the circle may be related; namely, its area. Area means surface; sometimes it is called size; for instance, the size of a building lot. The size of a lot is expressed by the product of its width into its depth. The statement "a lot is 50 by 100 feet" means 50 feet front and 100 feet deep. Often a piece of property is divided up into parts, and each part is given in square feet. When we read "1000 square feet of a loft for rent," this means the area for rent is 20 by 50 feet, or 25 by 40 feet or any size which will give the 1000 square feet. From this we see that the area of a rectangularly shaped surface is found by multiplying its width by its depth. The circle, however, is round, therefore its area cannot be determined in the same manner as the area of a rectangular piece of ground, except we can make it rectangular; this we can, at least we can find its rectangular equivalent near enough to solve the problem.

When we determined the circumference of the circle, we placed a number of pins around the circle: suppose we placed, as suggested, 12 pins. If so, remove every other pin, which would leave six. If the 12 pins were placed at equal distance from each other, the remaining six would divide the circumference into 6 equal parts. If on the paper a straight line is drawn from each one of the six pins on the circumference to the center-pin, the area of the circle will be divided also into six equal parts, which are wedgeshaped. They really are what is called mathematically "segments." The two straight sides of each segment are radii, and the curved side one-sixth of the circumference of the circle. If the distance between two adjacent pins upon the circumference is measured it will be found to be the same as the length of the radius, namely 3″ in our previous example. Now take up the sheet of paper and trim it down to the circumference of

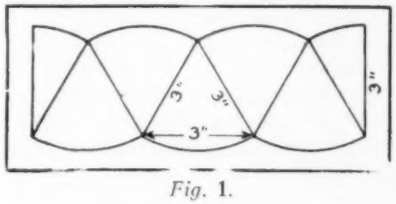


Fig. 1.

the circle, so that just the area of the circle remains, and cut the paper into six pieces, each piece being one of the segments. Then cut the last segment into two equal parts by cutting it on a line drawn from its point to the middle of its curved side and put together the seven pieces as indicated in Fig. 1, thereby obtaining a rectangle with two straight sides and two wavy sides. Each one of the two straight sides is equal to the radius r and the two wavy sides together are equal to the circumference of the circle, which is $d\pi$ or $2r\pi$, hence one wavy side is equal to $r\pi$. If we now multiply one of the straight sides, which would correspond to the width of the building lot example, by one of the wavy sides, which would correspond to the depth of the building lot, we would obtain the area of the rectangle; this gives the area of the circle as $r \times r\pi$. Mathematically this is written as $r^2\pi$, and is read: r squared π; but $r^2\pi$ what? In the case of the building lot the area is expressed in square feet; but if the length of the radius is given in inches, the area of the circle would have to be expressed in square inches, thus it would be $r^2\pi$ square inches. In the previous examples the radius of the circle was taken as 3 inches. For this length of radius the area of the circle would be $3^2\pi$ or 9π or 9×3.14 or 28.26 square inches. For every day calculations it is sufficiently close to take the value of π as 3.14.

To determine the cross sectional area of a pole at any point above the ground, place a string around the pole at that point, measure its length, which gives the circumference. In the previous pole example the circumference was found to be 29.25″; this is $2r\pi$; but we want to know $r\pi$, hence we divide 29.25 by 2 and obtain 14.625″. Then we have to divide this by π or by 3.14 and obtain 4.657″. Finally we multiply 14.625″ by 4.657″ and find 68.1086 square inches to be the cross-sectional area of the pole.

5. The Metric System

The Continental European, the South and Central American and even the Mexican measures things by the meter, which is divided into hundred centimeters. The modern American—that is, the American of radio times—is adapting his mind to wavelengths expressed in meters; that much he has accepted without a murmur from the scientists, who have discarded the yardstick long ago. The electrical engineer has gone farther, he has become accustomed to metric units in his scientific work; therefore the telephone man desirous to learn something about electricity and its applications must necessarily familiarize himself with a system so important. To kill two birds with one stone, we will give here an explanation of the system of "Absolute Units," which is the standard of today in physical science. This will acquaint the reader at the same time with the metric system of weights and measurements.

Nature's law that the motion of a body or mass varies with the time leads to the three operations of measuring length, mass and time, each of which is independent of the other and irreducible.

As a unit of "Length" the "Centimeter" has been adopted, which is the hundredth part of a meter.

As a unit of "Mass" the "Gram" has been chosen, one gram being the weight

of one cubic centimeter of water at a temperature of 4° Centigrade (40° Fahrenheit).

The unit of "Time" is the "Second," being the 86,400th part of an average solar day.

The system embodying these three units is spoken of and written as the "C. G. S. System."

From these three fundamental units may be derived units for any other physical quantity. The unit of "area" is the square centimeter (abbreviated cm^2); the unit of "volume" is the cubic centimeter (abbreviated cm^3). One meter = 100 centimeter = 1000 millimeter is written in abbreviation as 1 m = 100 cm = 1000 mm.

One kilogram means 1000 gram, written briefly 1 kg = 1000 gr. In the C. G. S. system length is symbolized by "C," mass by "G" and time by "S." In accordance therewith area is symbolized by C^2 and volume by C^3; C, C^2 and C^3 are termed the "Dimensions." Now, taking time also in consideration, the unit of "velocity" is obtained, which is that unit in which the distance of one centimeter is reached in one second. The dimension of velocity is written as $\frac{C}{S}$.

[Note—The physicists have adopted the method of indices in writing the dimensions of absolute units. By this method $\frac{C}{S}$ is written as $C\,S^{-1}$. Briefly stated the method or theory of indices is a kind of particular notation applied to certain mathematical operations (principally to powers and roots). At an earlier occasion we wrote r^2 for $r \times r$; in the same manner we can write a^2 (pronounced a squared) for $a \times a$; also we can write a^3 (pronounced a cubed) for $a \times a \times a$, and a^4 (a in the fourth power) for $a \times a \times a \times a$, in short we can indicate the number of times a factor occurs in a given product by placing this number above and to the right of the factor. This number is then called *"exponent."* If a factor has no exponent written above it, it is understood that it may be given the exponent 1, as that will not alter its value; thus we can write for a also a^1. (In a product the numbers multiplied together are designated as factors of the product.)

By "reciprocal" of a factor is meant the factor divided into 1. Thus the reciprocal of a is $\frac{1}{a}$; this can be written also as $\frac{1}{a^1}$ or also as a^{-1}; in a similar manner we can write a^{-2} for $\frac{1}{a^2}$; a^{-3} for $\frac{1}{a^3}$ — and so on.]

The rate at which velocity increases with increasing time is called "acceleration." The unit of acceleration is that unit by which the unit of velocity increases during unit of time. Dimension:

$$\text{Acceleration} = \frac{\text{Velocity}}{\text{Time}} = \frac{C\,S^{-1}}{S} = C\,S^{-1-1} = C\,S^{-2}.$$

To give to a body or mass acceleration, force is required. In mechanics force is defined as the product of mass into acceleration. The unit of "force" is that unit which gives to a mass of one gram in one second an increase of velocity equal to the unit of velocity; the unit of "force" is called the "dyne," a name derived from the Greek word for force. All our weights are forces, for the weights indicate the force by which gravity acts upon the mass. Gravity, as is well known, is the attraction which the earth exerts upon any body or mass. Gravity imparts to the mass a velocity of 981 cm. in the unit of time. Hence weight of 1 gr. = 981 dynes. In physics 9.81 (which is 9.81 m. per second) is denominated by the letter g. Dimension of force $= G\,\frac{C}{S^2} = C\,G\,S^{-2}$. A body or mass thus acted upon by a force is able to do work, which can be measured by the product of force into distance. Thus the unit of "work" is that unit which aggregates one dyne in moving the mass one gram through a distance of one centimeter. This unit received the name "erg" (from the Greek word for work). Dimension: Erg $= C^2G\,S^{-2}$.

The following items are useful to know.

1 footpound per second = 30.5 × 453.59 × 981 = 13,571,600 ergs. 1 foot = 30.479 cm. and 1 inch = 2.53995 cm.; for convenience say 1 foot = 30.5 cm. and 1 inch = 2.54 cm.; 1 pound = 453.6 grams; 1 meterkilogram = 100 × 1000 × 981 = 98,100,000 ergs (roughly 1 mkg. = 100,000,000 ergs).

One footpound per second means to move one pound one foot in a second.

Taking the time in which work is done into consideration, we arrive at power. The unit of "power" is the unit of work done in unit time, which can be expressed briefly by erg per second. In engineering work the unit of power or the erg is not often used, being too small a unit. Instead engineers measure the effect of force or the rate of work by the "horsepower" (HP.). In England and America 1 HP.= 33,000 footpounds per minute or 550 footpounds per second; that is, it is the equivalent of 1 HP. to lift 33,000 pounds one foot high in one minute; on the European continent 1 HP.= 4500 meterkilograms per minute or 75 mkg. per second. Electrical engineers use the "kilowatt" to measure power, one watt being ten million ergs per second. Thus 1 HP = 9.81 × 75 = 735.75 or in round numbers 736 watts or also 0.736 kilowatts. In the U. S. usually 1 HP. is taken as 746 watts, being derived from footpounds; namely, 1 footpound = 13,571,600 ergs $= \frac{13{,}571{,}600}{10{,}000{,}000} = 1.3716$ watts, and 550 footpounds = 746.438 watts.

$$\text{Dimension of unit of power} = \frac{\text{work}}{\text{time}} = C^2G\,S^{-3}.$$

It is not necessary to keep all these figures in mind; they are given here for reference. The dimensions are of no great importance to the practical worker, as for his use in daily life other units have been devised, which will be divulged later on, but familiarity with the metric system is becoming daily of more importance.

Monarch Rushes "Marine" Service to Storm Area

Chicago, Ill.—Roy Siemund, the husky young man in charge of the Supply Department of Monarch Telo. Mfg. Co., rushed his company's resources to the relief of the telephone companies that suffered from storm damage when March went out like a lion.

Siemund, taking a page from the history of the marines, was "first to fight" and send rush letters offering help in prompt shipments of any needed supplies to the companies whose lines had been laid low, when newspaper wire reports indicated the extent and seriousness of the storm. Response to this hair-trigger sales and service work was quick in returning to the Monarch's Chicago headquarters.

Copperweld Puts Out a New Ground Rod Clamp

Difficulty in securing good workmanship in soldering wires to ground rods has caused many telephone men to wish for a good mechanical clamp for this purpose. The Copperweld Steel Co., of Rankin, Pa., has developed a clamp which is particularly suitable for copperweld ground rods. A cup-shaped bolt or screw exerts great pressure on the wire or strand, flattening out the wire or strand and greatly increasing the contact area. The clamps are made for all standard sizes of ground rods between ⅜" and 1" in diameter.

Electrical Testing Laboratories Issues Bulletin

An attractive booklet describing its work in commercial testing, inspection and research work on impregnated, paper insulated, lead covered cable has been issued by the Electrical Testing Laboratories, 80th street and East End avenue, New York City.

Central Office Ringing Equipment Analyzed

By P. KERR HIGGINS

In practically all telephone exchanges having a hundred or more subscribers stations, it is customary to have some form of mechanical ringing, as it is found that the hand ringing is not only hard on the operator, but, in a measure at least, slows up the service. An early type of power ringing equipment consisted of a high power magneto driven by a water *motor* or belt driven from an electric motor. Later, the motor generator was developed and rendered very good service; in fact it is better than most of the interrupter types. The principal objection to the use of the motor generator is the cost of power for operation, and as a result of this it is very seldom used in the smaller exchange where economy must be the watchword. However, in the larger exchange its use is universal.

Ringing current generally is alternating in character; that is to say, one-half wave of current flows in one direction and a following half wave of current flows in the opposite direction. The result of such a current passing through the ringer coils is that the magnetism due to one-half wave, say the positive half wave, adds to the magnetism of one core, causing it to attract one end of the armature and at the same time neutralizing the magnetism or even reversing the polarity of the magnetism of the other core. This causes it to be either indifferent to the adjacent armature end or else repels it, which aids the other end in being attracted to the other core. As the positive half wave dies away, it is followed by the negative half wave in the reverse direction. The magnetism of this half wave adds to the magnetism of the other core, while neutralizing that of the first. As these half waves follow each other in regular order, the armature ends are first attracted to one and then to the other core producing the well known to-and-fro motion. Two gongs, properly located, are struck alternately by the hammer attached to the end of the armature of the ringer.

If instead of alternating current, we use pulsating current, then we have a different condition to meet and the construction of the ringer must be modified to meet this condition. Pulsating current is merely a current which is always flowing in the same direction and consists of short waves of either positive or negative current as may be prearranged. When a ringer is polarized it will respond only to current flow in one direction. These two types of ringer are shown in Fig. 1.

When ringing machines form part of the exchange equipment in the smaller exchanges, the hand generator is always equipped and used as a reserve. A switch is provided so that either the power or

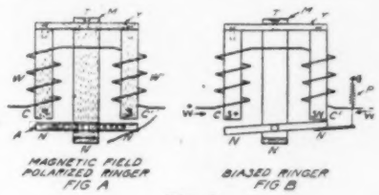


Fig. 1.

hand generator may be used as desired by the operator. A second switch is provided so that the operator may switch the power generator off and on at will. From the interchangeable switch, connections are run to the ringing keys of the cord circuits, which enables the operator, by merely pressing a button or moving a key lever, to ring her subscribers.

The circuit of a pole changer of the vibrator type is shown in Fig. 2. It will be noted that, in this type, the vibrator terminates in two contact arms properly insulated from each other. This type of machine like many others calls for two sets of batteries, one being known as the operating battery and the other as the ringing battery. The current from the ringing battery is distributed to four contact points, a positive and a negative polarity being arranged on either side of each arm of the vibrator. It will be noted that, with the vibrator arms drawn toward the magnet, positive current will be sent out to arm A and negative current to arm B. With the arm released from the magnet, the current is sent out in reverse direction. One of the objections to this type of machine is the possibility of burning the contacts due to short circuiting. To obviate this trouble, transformers have been used. The use of the transformer also makes it possible to decrease the number of cells of the ringing battery, as the transformer can be wound so as to use low voltage on its primary circuit and step it up in the secondary.

The machine of Fig. 2 delivers a straight alternating current output. In Fig. 3 is shown a more or less similar machine, but it gives not only alternating current but positive and negative pulsating currents as well. The contacts are arranged differently from that shown in Fig. 2 and two additional coils and two additional condensers are used.

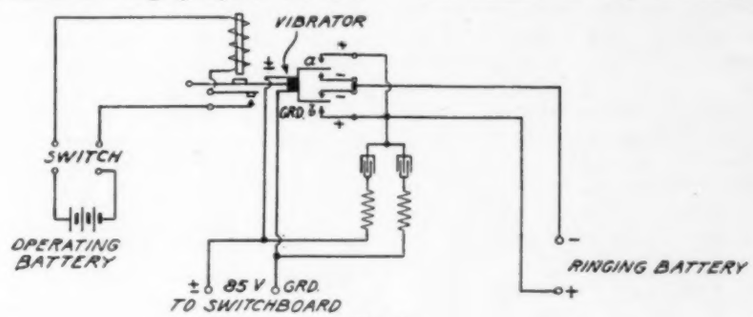


Fig. 2.

In later types, the operating battery is

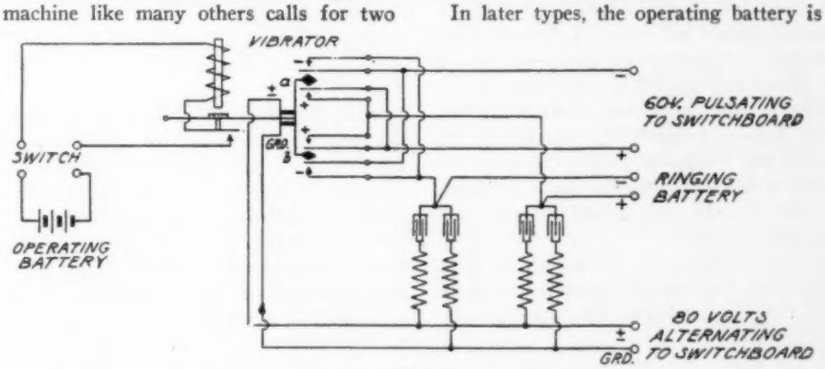


Fig. 3.

dispensed with and electric light current used in its place, while in still later machines batteries are dispensed with entirely, the ringing power also being furnished from commercial electric light circuits. In view of the fact that the ordinary alternating power circuit is of sixty cycles, which is too high a frequency to be used with a regular telephone ringer, special equipment must be provided in the ringing apparatus, which will operate on a sixty-cycle current but give out a ringing current at lower frequencies. We have spoken about frequency and, inasmuch as some of our readers may not be familiar with this term, it might be well to discuss this briefly before entering into the different types of ringing machines.

An Explanation of Frequency and Its Effects

The term frequency is used to express one-half the number of times that an electric current rises and falls in value in one second of time. Thus, in a two-pole ringing generator, the armature coil passes a north and south pole in one revolution, which causes the current to be generated positive in value, then falls and rises again in negative value and back to the original zero value. This rise and fall of a positive value is known as an alternation, the same being true of the negative value. Thus it takes two alternations to make one cycle or a complete period. An alternation is half of a cycle. An ordinary ringing generator having two poles with an armature running at the rate of, say, 1,200 revolutions per minute or twenty per second is said to have a frequency of twenty, while a lighting dynamo having eight poles with the armature running at 900 revolutions per minute makes 7,200 alternations per minute or 60 cycles per second which is the ordinary electric light current frequency.

Sound is produced by waves having a frequency of from sixteen cycles upward. The ear will detect these frequencies as high as 20,000. However, the telephone receiver is not quite so sensitive and the ordinary receiver will not detect sounds having frequencies above 5,000 cycles. The human voice has a range from thirty to 5,000; hence easily comes within the range of the telephone receiver. The fundamental tones having a frequency of 1,500 are necessary to the volume of the sound produced, while the higher frequencies running up to 5,000 are necessary to the character or quality of the sound produced. Speech could not be recognized without the higher frequencies.

The absorption or loss of energy in a telephone line depends upon the capacity of the line and the frequency of the soundwave.

The higher the frequency, the more its energy is absorbed by the capacity. The Pupin or loading coils are designed to overcome the effects of capacity and to equalize the absorption for frequencies between necessary limits, thus improving the transmission over very long lines.

As was discussed in the last issue of the TELEPHONE ENGINEER, the frequency of the waves to be transmitted governs the design of the respecting coil. The formula relating to such a repeating coil is that the number of turns on the primary, multiplied by the number of lines of force, is equal to the impressed pressure, divided by the frequency, leaving out certain constants. Coils designed for talking or ringing purposes must be specially designed for the purpose to

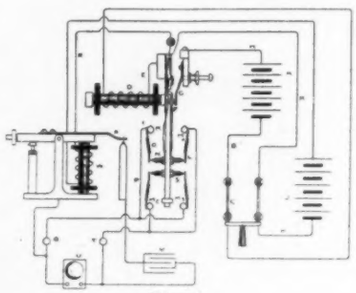


Fig. 4.

which they are put. Thus a repeating coil, used for talking purposes alone may be very small in size, with only a small amount of iron and a small number of turns. If we should try to ring through such a coil with a low frequency ringing current, there would be practically no current output in the secondary coil. Where a low frequency current carrying considerable power is to be used, a coil having much more iron in the core and low resistance winding is necessary.

Concerning Various Types of Pole Changers

Returning now to a discussion of pole changers, one of the simplest and one that is very popular with the small exchanges is the Warner Pole Changer.

The circuit is shown in Fig. 4. The

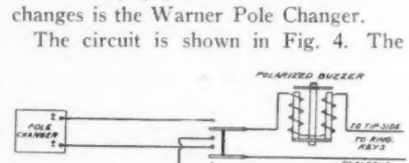


Fig. 5.

operating battery is shown at A and the ringing battery at J. It is hardly necessary to describe in detail this diagram as its actions can be readily seen from the diagram. The connections to the switchboard are made at Q and T, where binding posts are provided for that purpose. If more than one position is to be connected, separate taps should be run to each position so that should trouble develop, the position and trouble may be located easily by opening up the taps. So long as no operator is ringing, it is apparent that the circuit of battery J is entirely open; hence no energy is being expended. When the ringing key is operated, the battery delivers current only for the time that the lever is pressed into the ringing position. In order to keep the operator advised as to whether or not the current is going out, a vibrating or buzzer U may be introduced into the circuit. This may be one buzzer for each position or one buzzer for the exchange as a whole as may be deemed best. The object of the condenser is to prevent burning of the contact. Whenever an electric current is completed, a certain amount of energy is absorbed or stored up in the apparatus with which the circuit is connected. Now, if the circuit is suddenly opened, all of this energy will be liberated and is likely to produce dangerous sparking at the point where the continuity of the conductor is broken. This same phenomena occurs in the case of the pole changer although on a much smaller scale, yet sufficient to damage the contact points in a relatively short time. In a sense, the condenser acts to the electric current like the air reservoir upon a hydraulic ram or pump. It is simply a receptacle in which electricity can be stored, so that when the armature swings away from the contact springs, the energy released by the rupture of the circuit finds an overflow in the condenser, and the charge on the line rushing toward the point where the circuit has been ruptured, thus is enabled to escape into the condenser and prevent sparking. If, however, the condenser constantly were left in the circuit, every time that the armature swung to and fro the battery would charge the condenser and cause a small drain in the battery.

To obviate this, is the office or function of the relay W. So long as no ringing key is being operated, the ringing circuit is open and magnet W is not energized; consequently, contact X is open and the condenser cut off. The act of the operator pressing the ringer key energizes the magnet W and the condenser is automatically bridged across the circuit and in position to prevent danger of sparking. In Fig. 5 is shown the connections for changing from the hand generator to the pole changer and the introduction of a polarized buzzer previously mentioned. In some cases, an ordinary polarized ringer may be used for this purpose, but if connected in series, a hundred-ohm polarized buzzer is considered better.

A simplified circuit of the Warner Pole Changer is shown in Fig. 6. In this diagram, it will be noted that the relay coil M is wired in series with the negative battery lead between the fifty-cell ringing battery and the vibrator. The contact of this relay (K and L) is wired in

series with the condenser and the two bridged across the line binding posts. Under these conditions, if the vibrator is running properly, the current cannot fail to flow from the fifty-cell battery through the relay coil M and the vibrator to the binding posts and bell. This will cause

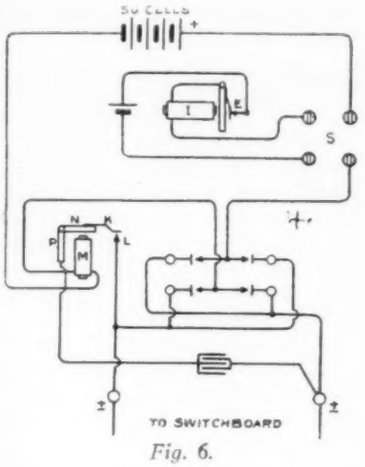


Fig. 6.

the magnet M to attract the armature N so that K will touch L. This connects the condenser across the line.

An Edison or other similar cell may be used for the operating battery. The current required to operate the vibrator of the Warner Pole Changer depends somewhat upon the adjustment of the vibrator contact. About one-tenth of an ampere may be taken as an average value. In a ten-hour day the current consumption would be the average current times the number of hours or a total of one ampere hour. If a vibrator operates only ten hours a day and the daily consumption is one ampere hour, a 500-ampere-hour Edison cell should last about 500 days. Hence, it is expected ordinarily that such a cell or cells would operate the pole changer on an average of nine months to a year where the average use is from fourteen to fifteen hours per day.

Some Hints Re Maintenance of Pole Changers

The following hints are given to those who are using the Warner Pole Changer, in the hope that we may enable them to get the best results from that type of machine:

First: See that the dust-proof glass cover is kept on the pole changer at all times, as dust on the contacts produces trouble.

Second: Note that the vibrator arm should vibrate at a constant rate, both as to frequency and length of swing.

Third: The local circuit contacts should be so adjusted that the vibrator will start from zero or rest when the battery switch is closed.

Fourth: The local circuit contact points must be kept free from dust or dirt. If this is not done, the ringing will be spasmodic and the vibrator is liable to stick.

Fifth: The ringing circuit springs must be adjusted properly and the contacts on one side of the vibrator must open at least one-eighth of an inch before the connection is made on the other side.

Sixth: The ringing relay also must be properly adjusted. This may be done by bending the contact spring and turning or adjusting the screw up or down.

Seventh: The armature is adjusted or regulated by means of the adjusting weight. In some cases, it even may be necessary to take off one or two of the washers. This is especially true where no up and down adjustment has been provided.

Eighth: To increase the frequency of the vibrator the following adjustments are suggested: Adjust the local circuit contact closer together; increase the output of the operating battery current; adjust the armature weight further from the end of vibrator arms. To increase

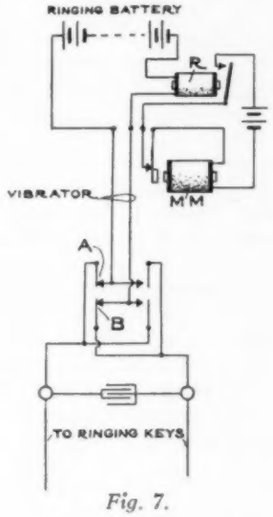


Fig. 7.

the length of swing, it is necessary to place the adjusting weight nearer to the end of the vibrating arm.

Some genius conceived the idea that it might be convenient to have a relay in the vibrator circuit of the pole changer and while the writer has not had much success in the use of such a relay, the diagram in Fig. 7 is shown for those who are interested. This relay is operated when the operator presses the switchboard keys, bringing the vibrator into action. In Fig. 8 another circuit is shown of the Warner Pole Changer so arranged as to give both pulsating and alternating current. It will be noted that this is done by adding a tap on each end of the main ringing battery. In this diagram, the battery which keeps the vibrator moving has been omitted in order to simplify the circuit. It also is noted that this arrangement will not bring the condenser into play when ringing with pulsating current. It would require two additional relays and two condensers wired into the two new circuits the same way that the regular one is wired.

The Kellogg No. 9A Pole Changer is assembled in a cabinet 17½ inches by 17½ inches with a hinged glass door and is intended to be installed in a vertical position. There are two types of this interrupter, one with a vibrator relay or motor magnet, wound to operate from a closed circuit battery with a pressure of 7/10 of a volt. The other type is equipped with a relay, wound to operate from a series of dry cells of 24 volts, or from the office storage battery or possibly from a Delco lighting system. The local circuit consists of a high resistance relay with a non-inductive coil of high resistance in multiple, the operating battery, one-half of the double pole switch and the vibrator contact. The other circuit, known as the pole changer circuit, consists of a vibrator arm equipped with three contact points properly insulated from each other, three contact springs (one each side of the arm), a resistance and condenser bridged across the alternating and grounded terminals, together with a ringing battery of from fifty to one hundred cells and the other half of the switch. The circuit is shown in Fig. 9.

It will be noted that in this type of pole changer a resistance is permanently bridged across the vibrating relay. To prevent pole changing contacts sparking or arcing, a non-inductive resistance connected in series with a condenser and bridge across the alternating and ground terminals is provided. It is not considered best in pole changers of this type to use dry cells to operate the vibrating relay, but rather to use batteries of the Edison or Gladstone Lelande type.

The amount of battery required for

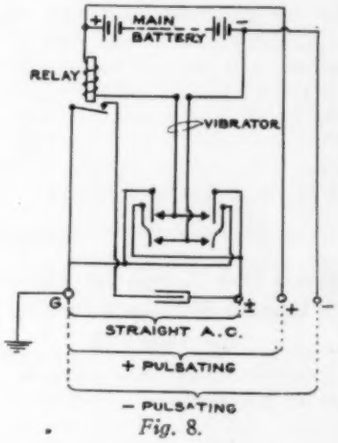


Fig. 8.

ringing will vary with varing conditions from 75 to 100 dry cells, that is to say if the lines are short or local in character, the smaller number may be used and where ringing is necessary on long, rural or toll lines, it may be found necessary to use the maximum number of cells.

This battery must be connected up in series and connecting leads should not be less than No. 16 B. & S. copper wire. The wire from the carbon terminal should be connected to the ringing battery positive binding post and the wire from the zinc terminal to the negative binding post.

The batteries should be so located and arranged as to be convenient for examination, testing and renewing and always disconnect the interrupter and connect up the battery in series with about 800 ohms resistance. This resistance represents the load and must remain connected during the test not only of the total voltage but of each cell. Great care should be taken to see that all contacts are clean and tight as one loose or dirty connection will cause trouble.

The ringing battery leads should be provided with a fuse of two ampere

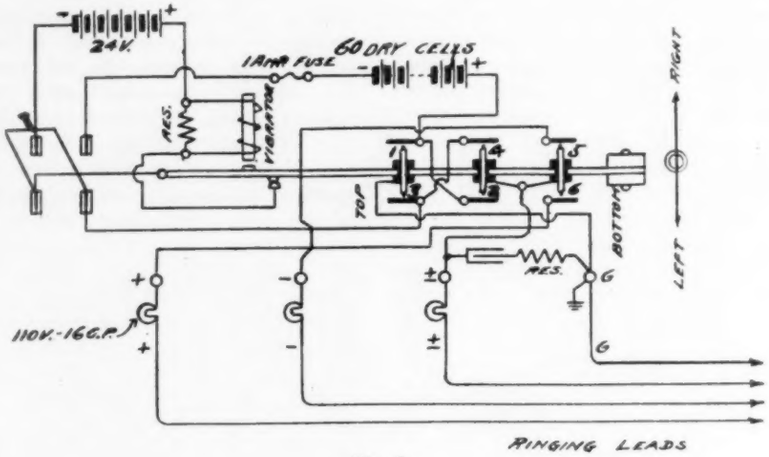


Fig. 9.

should be in an upright position. It would seem unnecessary to state that the dry cells should be in an upright position, but the writer has found several otherwise good telephone men who seemed to think that because the cells are called "dry" they will operate any old way. As a mattery of fact, dry cells will deteriorate very rapidly if kept in any other position than upright. The voltage of the batteries should be tested at least once every two weeks to make sure that they are giving the necessary voltage, and not wait until complaints are received that the subscribers' bells are ringing weak. Should the voltage show low on the test, it is economy to test out each cell and all those showing less than one volt should be removed and additional cells added to bring the total voltage up to the proper output. It has been found convenient in making this battery test to carrying capacity. Should the vibrator arm stop at any time, this may be due to an opening in the local circuit, an open fuse, a run down battery, or worn contacts, or it may be due to insufficient tension on the spring or the vibrating arm swinging too near the magnets. Great care should be taken when necessary to clean the contacts, using very fine sandpaper for this purpose. Springs never should be adjusted while the ringing battery is connected. Either open the circuit or remove the fuses. It has been found convenient to reverse the local circuit contacts about once a week as current flowing continually in one direction has a tendency to roughen the contacts. It also is found good practice to insert in the ringing leads suitable resistance. This is necessary to limit the current output and prevent the burning of contacts and incidentally reduces current consumption.

Illinois Bell Telephone Company Earned $8,236,426 During the Year 1925

Expenditures for new plant to take care of the demands for service in its territory were the greatest last year in the history of the Illinois Bell Telephone Co., as shown by its annual report. Expenditure for new construction in 1925 amounted to $29,381,505; net addition to plant was $288.29 for each telephone gained. The gain for the entire territory was 71,200 stations of which 48,828 represented gain in Chicago. During the year, a new toll cable was installed jointly with the American Tel. & Tel. Co. between Peoria and St. Louis and the extension of the Chicago-Joliet cable to Peoria will give an all-cable route between Chicago and St. Louis. Approximately 1,700 miles of toll line were rebuilt as a result of the severe sleet storm of December 1924. The cost of restoring service and replacing plant destroyed by the storm was approximately $2,500,000.

Gross revenues of the company from telephone operation were $60,944,656.51 and telephone operating expenses were $43,809,668.94. Net earnings, after deductions, were $8,236,425.90. Dividends of $5,600,000 were paid and the balance, after appropriating $900,000 for employes benefit reserve, was carried to surplus The company's fixed capital at the close of the year was $183,098,496. Its bonded indebtedness was $49,252,900. $10,000,000 in common stock was issued during the year, bringing the total up to $80,000,000.

Southern New England Had Busy Year in 1925

A net gain of 16,380 stations or 7% during the year 1925 is shown in the annual report of President James T. Moran to the stockholders of The Southern New England Telephone Company operating in the State of Connecticut. An unusually large increase in traffic was experienced, both local and toll call increasing over 10% above the preceding year. Over 72 per cent of the toll calls in the state are now being handled by the A-B method and the marked increase in volume of business where the A-B service is available indicates that the improvement in speed effected by this method fills a real public need. Gross and net plant additions were $5,911,000 and $4,044,000 respectively. In addition to many exchange additions, toll cables were completed between Norwalk and Danbury and between Waterbury and Meriden, as well as a link between Clinton and Saybrook of the ultimate cable between New Haven and New London. The balance sheet shows assets of $43,477,086 against which are issued $24,000,000 common stock, $1,000,000 bonds and $3,000,000 advance from the American Tel. & Tel. Co. The depreciation reserve is $10,963,008 and the corporate surplus is $1,660,945. Telephone operating revenues for 1925 were $11,101,678 and operating expenses $7,796,507, leaving net revenue of $3,305,171. After deductions for taxes, rents, etc., the net income was $2,209,612. Dividends of $1,800,000 were paid and $100,000 was appropriated to the Employees' Benefit Fund. The balance of $309,612 was carried to surplus.

Westinghouse Issues a Catalogue on Instruments

Catalogue No. 8931, by the Westinghouse Electric and Mahufacturing Co., Pittsburgh, tells of instruments for alternating and direct current for use in radio work, in checking operation of motor starters and starting controllers, in power plants to check opens and shorts on relay circuits, and many others.

Beach, Wash.—Island Improvement Club is sponsoring installation of a telephone system here. C. R. Granger is a moving factor in the work.

"Heart of System" Calls for Careful Study

SPECIAL CORRESPONDENCE

The present-day switchboards are the natural development of the older types and comprise the features which experience has found desirable. The best grasp of the subject can, therefore, be obtained by following the development from early types to those of today. An outline of the history of the switchboard sufficient for this purpose follows:

Early Switchboards

The first exchanges were small rooms rented in the business district and the number of subscribers at first provided for was not often in excess of one or two hundred. The relative number of business houses that had telephones was small and the number of calls per day corresponded to the number of persons it was possible to reach by telephone. All that was thought necessary was to connect the parties who wished to speak. At first there was no supervision except by the operator. When the operator had time, the connection was tapped to see if the parties were finished. It was seldom that a party wanted more than one number at a time, if he did, he had to wait anyhow. At this time all the subscriber lines were composed of one metallic conductor and ground return. A wall type subscribers' instrument was used for the operator's telephone. It was screwed up at the left of the switchboard and there was a plug attached to the cord for answering. The desired connection was made with a cord with a plug at each end, one plug being inserted in the jack of the calling subscriber and the other in the jack of the called subscriber. The calling subscriber then rang up the party to whom he was connected. The subscribers' circuit was very simple; a jack, which was also used as a lightning arrester by providing a saw edge on one part and a drop with one side grounded. The cords, when not in use, were hung on a hook provided for that purpose.

The next advance was to reduce the size of the apparatus so that a larger number of subscribers could be reached by an operator. Then a clearing drop was inserted in each cord circuit and the cord shelf was provided to accommodate this arrangement.

At this time it was not possible to tell just what was the state of the connection when the clearing drops fell. It often happened that the subscribers had not spoken when the connection was taken down, this came about in this way: After asking the operator for the number required the subscriber would ring but if he rang before the connection was completed the wanted subscriber would not get it and when he rang again the connection would be taken down because the clearing drop would be operated. This led to the introduction of ringing keys, one for each pair of cords, and arranged to ring on the calling cord.

The Next Step Added to Listening Key

It was only a short step from this to provide listening keys to make supervision easier at the same time the operator's telephone was incorporated in the board. The next great improvement was the use of two-wire lines in place of grounded lines.

Later additions were, a ringing key for the answering cord, the chest transmitter and combining the drops and jacks and listening and ringing keys.

The multiple switchboard was a very early development, early installations using five-point break jacks and later a three-point branching jack as is now in central battery multiples.

Magneto Switchboard Maintenance Deserves Study

The magneto switchboard today constitutes a large and important class of equipment and its maintenance deserves careful study.

The heart of a telephone system is the switching apparatus. If this is defective the whole plant suffers. It also happens to appear to be the most complicated part. Therefore, it is well understood the rest of the apparatus should be quite simple.

To demonstrate how simple a cord circuit is, it has been drawn so as to show how each circuit is arranged. A cord circuit is composed of four circuits which are: (1) a circuit to connect the subscribers so that they can talk; (2) a circuit to enable either subscriber to be called; (3) a circuit to enable the operator to answer the calls and supervise them; (4) a circuit to operate a clearing signal. These circuits are shown in Figures 1, 2 and 3.

Figure 1 shows the circuit (1) used to connect the subscribers, it shows at the left a plug marked A which is used to answer a call and is referred to as the answering plug.

Next to the right is shown a spring assembly of six springs, the two longer springs with curved ends are separated at the curved part by moving a lever or key at the wish of the operator. They are shown in the normal position. This is the through or talking position.

When the lever or key is thrown it will be evident that the two long springs will break contact with the two inner springs against which they are shown resting, and will then connect with the two outer springs.

Such an assembly of springs operated by a lever is called a key and this is the ringing key for the answering cord marked R A. Next on the right is another assembly of springs marked S. It will be noticed that the inner springs are different. They do not connect with the moving springs at any time but are given a "set" outward and when the key is operated they connect with each other.

There is one other difference in this key which is not possible to show on a drawing. It is a locking key, that is, it stays in the position in which it is released. Ringing keys return to the normal position when released; they are non-locking. This key is the listening key and performs two duties; closing the operator's battery circuit by means of the inner springs, and connecting the

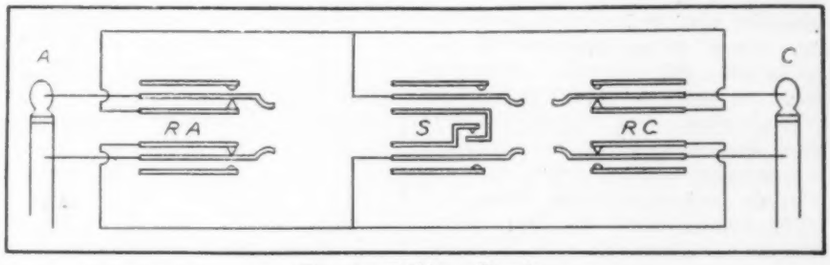


Fig. 1—Talking Circuit

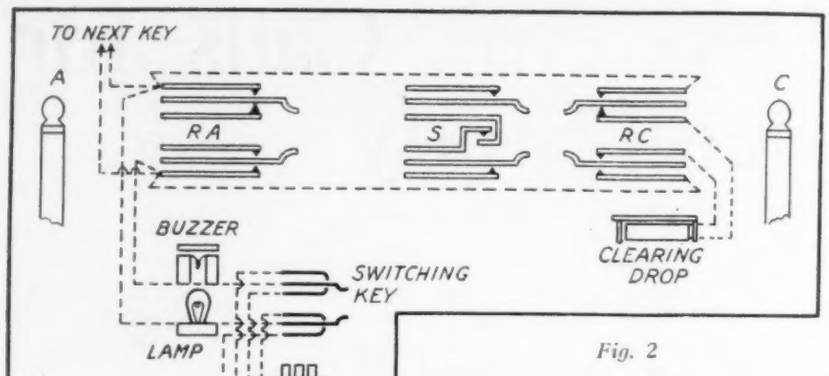


Fig. 2

operator's circuit with the subscribers' talking circuit.

On the right of the listening key is another ringing key, in all respects resembling the one first described; this one is used to ring on the calling cord, marked R. C. At the extreme right is shown another plug marked C, which is the calling plug attached to the calling cord.

The lines drawn between these pieces of apparatus represent wires and are mostly double cotton covered tinned copper wire. The outer covering of such wire is colored so as to distinguish wires of different circuits. The wire is supplied in twisted pairs, the pairs consist of a colored wire and a plain return wire, one marked wire being sufficient in each pair.

Still referring to Figure 1, it will be seen that, if a subscriber has been answered with the answering plug and the calling plug has been inserted in the jack of the wanted subscriber, the wires will form a connection between the subscribers. Tracing this out it is seen the circuit extends from the tip of the answering cord to the center spring of the ringing key, to the inner spring of the same key, to the inner spring of the ringing key for the calling cord, to the center spring of that key, to the tip of the calling plug, to the called subscriber and back on the return wire not shown, to the sleeve of the calling plug, to the center spring of the ringing key, to the inner spring of the same key, to the inner spring of the ringing key of the answering plug, to the center spring, to the sleeve of the answering plug, to the calling subscriber and back, not shown, to the tip where we started from.

This circuit is a two-wire circuit which must be kept free from trouble. It has some associated circuits which must also be kept free from trouble.

The talking circuit has been rather fully described because it has been understood it will not be necessary to go so fully into those which follow. To remember that every circuit must be complete before current can flow, will be a help. There is a branch of this circuit shown connected to the center springs of the listening key, but in the through position shown that circuit is not complete and so no current can flow.

Mention has been made of combining the listening and ringing keys. This is accomplished by using one lever to operate two spring assemblies, as shown at the right, the two spring assemblies face each other for this purpose.

The Signalling and Clearing-out Circuits

Figure 2 shows the same plugs and keys as Figure 1, the wires shown in Figure 1 are left out.

This drawing shows the last two circuits of the four which together make a cord circuit, they are the signalling circuit and the clearing circuit. The wires are here shown as broken lines, the signalling circuit is a series of dashes and the clearing circuit a series of dots and dashes. It is convenient to distinguish between these circuits and those shown in Figures 1 and 3, therefore wires are drawn in four ways as follows: Talking circuit, thick lines; operator's circuit, thin lines; signalling circuit, broken lines; clearing circuit, broken and dotted lines. This will be appreciated when all four circuits are drawn on one sheet.

Referring to Figure 2 it is seen that on the outside springs of key R A there are three wires. They are: A short bridge to the outside spring of key R C, a short bridge to the next key and the third wire goes to the supply of signalling current. In each side of this last pair of wires there is a device; in one side is a buzzer and in the other a lamp. The buzzer informs the operator if she is ringing on a normal circuit and is an audible signal; the lamp is only required if there is more than one operator using the supply, it is helpful in saving the dry cells of pole changers in any case where they are used.

In small offices where the number of night calls is small the machine ringer is often stopped at night and a hand generator is used.

A switching key is shown which changes the connections for this. The hand generator is shown just below, the power generator or pole changer is not shown, it is connected to the punching marked P G. The switching key is shown in the normal position: when the hand generator is in circuit. Throwing this key disconnects the hand generator and connects the power circuit. This is easily traced. The hand generator is on the inner springs, the power generator on the outside springs, the center springs go to the output.

When key "R A" is thrown the ringing circuit is connected to the answering plug and when key "R C" is thrown the ringing circuit is connected to the calling plug "C." Referring now to the clearing circuit it will be seen in Figure 2 that the inside springs of the key "R C" are connected to the clearing drop. It will be remembered that these inner springs form part of the talking circuit, so that the clearing drop is connected to the talking circuit. This does not cut down the volume of the

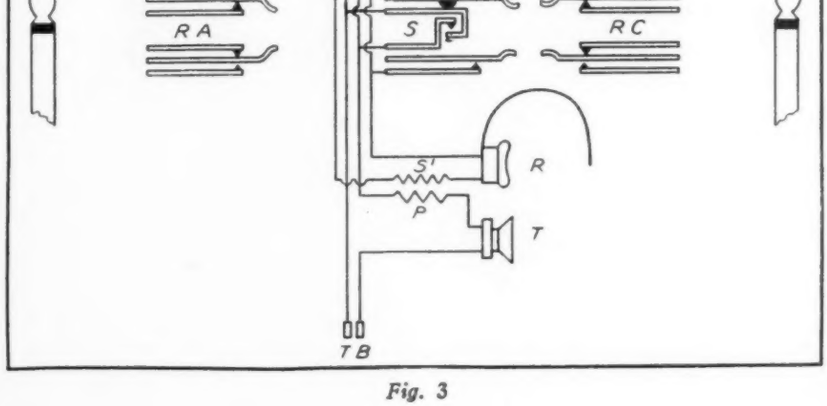


Fig. 3

speech to any serious degree because the drop is so constructed as to absorb very little of the high frequency talking current. It will operate when either subscriber rings off.

The Operator's Telephone Circuit

Figure 3 shows the same plugs and keys and in this case the wires which were shown in Figures 1 and 2 are left out; at the same time it will be kept in mind that they are there. Figure 3 has the lines drawn which represent the wires of the operator's circuit.

There are really two circuits here, the transmitter circuit, called the primary circuit, and the receiver circuit, called the secondary circuit.

In the position in which the listening key is shown both circuits are open. At T B the wires from the transmitter battery are connected. They are not shown because the battery is not part of the switchboard.

When the listening key "S" is thrown both circuits are closed; the center springs then connect with the outer springs and the inner springs connect together.

Tracing the primary circuit first: From connection "B" to the transmitter "T," to the primary winding of the induction coil "P," to the lower inner spring of the listening key "S," to the upper inner spring and back to connection "T," through the transmitter battery not shown, to "B," completing the circuit.

Tracing the secondary circuit: From the left hand end of the secondary winding of the induction coil *S* trace the wire to the top spring of the speaking key "S." Now it will be remembered that the center springs of this key are connected to the two sides of the subscriber's talking circuit and it is this circuit, which completes the secondary circuit, continuing them from the top spring of the key "S" to the center spring of the same key, to the subscribers' talking circuit, to the center spring of lower side of key to outer spring, to the receiver "R," to the right hand end of the induction coil, through the secondary winding to the point where we started. This is the condition of the circuits when the listening key "S" is thrown.

As the operator's circuit is used by any of the cord circuits the wires are extended from key to key as indicated at the top of the drawing by the words, "to the next key."

Telephone Business Is Booming in Spain

Madrid, Spain—Announcement is made by the International Telephone and Telegraph Corp. that a new company, the Standard Electrica Sociedad Anonima, has been organized in Spain for the manufacture of telephone apparatus and equipment. This company will be affiliated with the International Standard Electric Corp., formerly the International Western Electric Co., which was acquired last year by the International Telephone and Telegraph Corp. It will take over the Barcelona factory and other properties of the Telefonos Bell, S. A., a subsidiary of the International Standard Electric Corp. and will begin, immediately, the erection of a telephone cable factory in Santander and an apparatus factory in Madrid. This increase in manufacturing activities is because of the rapidly expanding requirements of the Compania Telefonica Nacional de Espana, which was organized by the International Telephone and Telegraph Corp. in association with a group of Spanish bankers.

The Duke of Alba is president of the new company, and on the executive committee with him are the Marques de Urquijo and Messrs. Behn, Pingree, Baker, Dodge and Proctor.

Brussels, Belgium.—There are now 347 telephone exchanges in operation in Belgium, with a total of 105,626 subscribers.

Franc's Fall Raises French Rates

Paris, France—Further fall of the franc has been followed by a fresh increase in foreign telegraph and telephone rates. The basic rate now has to be multiplied by 5.3 for international messages, as compared with a multiplication of 4 at the beginning of August, 1925, and by 5 on December 10, 1925, says Reuter. Contrary to the practice obtaining hitherto, substantial increases have also been made in French colonial rates, the same multiplier index being applied as for international telegrams except in the case of messages sent to French colonies by wireless, or via Dakar, in which case the basic rate will be multiplied by 3.5 only.

Tokyo Orders American Automatic Exchanges

New York City—International Standard Electric Corp., formerly the International Western Electric Co., has received through its subsidiary, The Nippon Electric Co., Ltd., an order for five automatic offices in the Tokyo district, involving a total of approximately 14,200 lines, initial equipment. A supplementary order is for 14,900 message registers, and apparatus for forty-two positions of call indicator equipment.

Spokane, Wash. — Interstate Utilities Co. construction program for 1926 calls for expense of $200,000, according to E. R. Hannibal, supt.

Russian Telephone Rebuilding to Be Done by Americans?

Warsaw, Russia.—The Soviet Government's intention to spend $100,000,000 in raising the telephone service in Russia to modern standards involves invitation of the co-operation of large American electrical companies. Russia has at present only one telephone to about every 1,160 people; during 1922 the number of telephones in Petrograd decreased from some 40,000 to 8,966, though the population of the city increased by 300,000; while in Moscow, the headquarters of the Soviet, telephones decreased from more than 54,000 to about 25,000, in the face of an increase of population, during the same period, of some 500,000. The government desires to increase the number of telephones in the country from 120,000 to 1,000,000, linking up the village centers over widely-scattered areas. It is also anxious to establish long-distance communication with Warsaw, Berlin, Paris and London. It is understood that the International Standard Electric Corporation has informed the Soviet Government that it is not prepared to re-enter Russia until it has been compensated for the confiscation of its plant, which was nationalized by the government after the revolution. The Government, while making no guarantees, is said to be willing to discuss terms for a reasonable adjustment of the claim.

Rebuilding Is Lively in Jugo-Slavia

Belgrade, Jugo-Slavia. — When the Kingdom of the Serbs, Croats, and Slovenes was created, its telephone and telegraph lines were in complete disorder, and the entire pre-war system in Serbia had been destroyed. The Jugo-Slavian Ministry of Posts and Telegraphs had to practically rebuild the systems. The services now rendered are adequate, and not only are all centers of the country connected by wire, but Belgrade and Zagreb have direct lines to the capitals of all the neighboring countries, except Italy, this line extending only to Trieste. At the end of 1924 there were 14,605 kilometers of telephone lines with 27,457 subscribers, and 20,039 kilometers of telegraph lines. Since 1921 new telephone lines have been put in service between Belgrade and a number of cities, and it is said by commerce reports that 27 telephone and telegraph lines are now under construction.

Caracas, Venezuela.—The Government of Venezuela recently granted a concession to install and operate an automatic telephone system throughout the country. Work must begin within six months.

LINE AND DESK

PIKE POLE METHOD OF POLE TESTING.

The "Pike Test" is one method of testing poles and shall be applied wherever the means are available, as described below:

(a) Use standard pike or pike pole cut to an eight-foot length.

(b) Apply the pike test to both sides of the pole at a height of about ten feet from the ground and at a right angle to the direction of the lead.

(c) Rock the pole sufficiently to determine its condition. If the pole cracks or breaks, it shall not be climbed without first safeguarding it by substantial guying.

Note—A report shall be made promptly to the foreman or wire chief of all cases where a pole is cracked or broken in testing.

(d) Particular care must be exercised when applying the pike test to poles where the breaking off would be likely to cause it to fall and bring it, or the plant supported by it, in contact with other aerial plant, interfere with traffic or cause property damage or injury to others.

(e) Test pikes shall be carried at all times by construction and line gangs and by all employees using vehicles, whose duties require them to climb poles requiring tests. They shall also be located in central offices and storerooms at such points as are designated by the district head.—"Bell Telephone News."

A Pole Which, Tested from the Road Side, Withstood the Test, Broke When It Was Tried from the Field Side.

JOINT POLE LINE HAZARDS.

Certain hazardous conditions which may arise in joint pole line construction are pointed out in a recent number of "The Travelers' Standard." Sometimes there is a disposition to "let George do it," in the case of certain minor details of repairing, inspecting and maintaining the poles. For example, the employees of one utility may make alterations or repairs in a non-standard way which may not comply with established safety principles. Employees of the other utility may fail to note the condition and the records show that accidents occur abundantly under these conditions.

Lack of proper spacing, both vertically and horizontally, introduces an important hazard. The lineman must exercise great care that his body or the tools which he may have with him do not come into contact with a live wire while he is in contact with a grounded device or a circuit of different voltage. Ample climbing space (it should never be less than 24 inches wide, when measured horizontally; and, preferably, should be at least 30 to 36 inches wide, according to voltage) is particularly desirable when wires of a communication or signal circuit are above the wires of a light and power company.

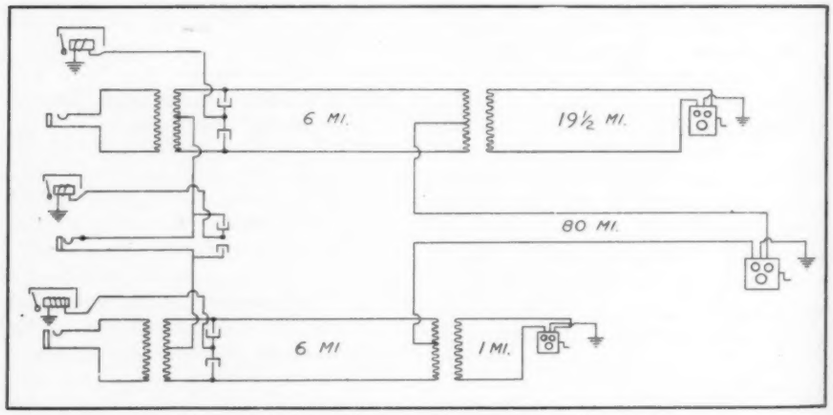
The agreement between companies jointly using a pole line should be specific regarding the standards of construction that are to be followed. Standards of construction and methods of work that have proven eminently safe on individual pole lines may prove to be extremely hazardous to the workmen of all companies on joint pole lines.

WHAT DO YOU KNOW ABOUT THIS CIRCUIT?

A Canadian subscriber submits a sketch and asks us to give our opinion as follows:

"Would you please give us your opinion on phantom circuits worked with push buttons for calling central on two lines in accordance with accompanying diagram."

In answer, we must say that we have had no experience with the type of circuit indicated, but our first impression is not favorable because of the unknown difficulties of maintaining balance of phantom circuits. There would seem to be no reason for this arrangement if only one telephone is to be used on a line as shown in the sketch. The condensers and



"What's Wrong with This Picture?" Canadian Asks.

THE WAR DEPARTMENT OF
THE UNITED STATES OF AMERICA
RECOGNIZES IN THIS AWARD FOR DISTINGUISHED SERVICE
THE LOYALTY ENERGY AND EFFICIENCY IN THE PERFORMANCE
OF THE WAR WORK BY WHICH
The American Telephone & Telegraph Company
AIDED MATERIALLY IN OBTAINING VICTORY FOR THE ARMS
OF THE UNITED STATES OF AMERICA IN THE WAR WITH
THE IMPERIAL GERMAN GOVERNMENT AND THE IMPERIAL
AND ROYAL AUSTRO-HUNGARIAN GOVERNMENT

Telephone Preparedness

NINE years ago, when this nation was preparing for war, it found the Bell Telephone System ready for service at home and abroad. The war found the Bell System prepared. From its technical forces so needful to meet our war-time activities in this country, fourteen battalions were organized to carry to the front the highest developments of the telephone art. No other nation had so complete a system of communication to aid in mobilizing its resources. No other nation was able to put into the field a military communication system of equal effectiveness.

Fifty years ago Alexander Graham Bell, the inventor of the telephone, gave to the world a new art. He had the vision of a nation-wide telephone system by which people near at hand and far apart could talk to one another as if face to face. He foresaw a usefulness for the telephone which could not be achieved without innumerable developments, inventions and improvements, to him unknown. But not even he foresaw the marvelous applications of telephony which gave to the American armies that fighting efficiency which is possible only when there is instant exchange of complete information.

Since the completion of its service in time of war, the Bell System has devoted itself to the extension of the telephone art as one of the great agencies for the development of the pursuits of peace.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

BELL SYSTEM

IN ITS SEMI-CENTENNIAL YEAR THE BELL SYSTEM LOOKS FORWARD TO CONTINUED PROGRESS IN TELEPHONE COMMUNICATION

the grounded drop circuit introduce additional places where unbalances might occur and there will be a certain amount of transmission loss in both the physicals and in the phantom circuit due to the fact that the two condensers in series are bridged across. If any of our readers have had experience with this type of circuit we would be pleased to hear from them.

ANOTHER PHANTOM TRANSPOSITION PROBLEM

Phantom transposition problems still continue to come into this department, indicating the wide interest in this type of circuit. An Oregon subscriber sends in a sketch (Fig. 1) and asks for the proper transpositions for the various circuits.

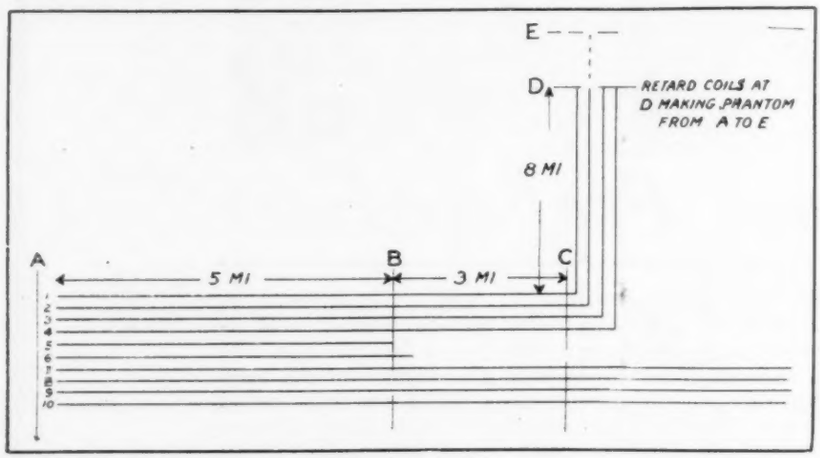


Fig. 1.

This layout lends itself readily to the standard transposition scheme as the distances from A to C and from C to D are each eight miles, which is the length of a standard transposition section. Since the circuits on pins 1, 2 and 3, 4 are to be phantomed, these circuits should be transposed as shown in Fig. 2, making a standard section between A and C and another standard section with the same transpositions between C and D. Circuit 5, 6 should be transposed according to the regular scheme throughout its length, although it does not run the entire distance of the first transposition section. Circuits 7, 8 and 9, 10 will have the regular physical transpositions but will have no phantom transpositions. If these circuits are to be phantomed in the future, a type 1 phantom transposition should be cut in on every "C" pole and additional side circuit transpositions should be cut in on circuit 7, 8 on the two "D" poles. The entire layout will be clear from the sketch shown in Fig. 2.

BUGS WE HAVE SHOT.

Man installing magneto telephone in small town hardware store. Desk set being desired on office desk which was placed against partition, back of which was stock room. Man decided to do a good job and have wiring concealed. He bored through the back of roll top desk and partition in one operation, passed the desk set cord and mounted terminal block and batteries in stock room. That night when subscriber started to close desk, it refused to operate and investigation disclosed a ¼" hole both through back of desk and roll top. The adjustment was made by Local Manager.—Contributed.

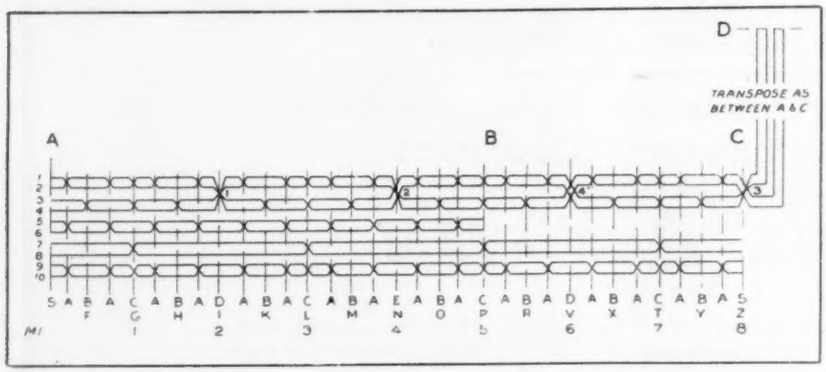


Fig. 2.

The Newark (O.) Telephone Co., W. L. Cary, purchasing agent, is in the market for cable, messenger, hardware, wire and other supplies needed for its 1926 extension program estimated at $25,000 worth.

Harry Faris Enters Engineering Field

Kansas City, Mo.—Harry N. Faris has resigned as southwestern division manager for the Kellogg Switchboard and Supply Co. to engage in telephone engineering work. He has been retained as technical engineer for the United Telephone and Electric interests with headquarters at Abilene, Kan. Faris' many years of successful experience in the telephone industry qualify him to serve with satisfaction in handling the engineering problems that confront the Independent companies. His business among the southwestern companies, with whom he is especially well acquainted, already has assumed pleasing proportions.

Mr. Faris has his headquarters at 308 West Sixth street, Kansas City, Mo.

Chicago to Have Independent Meeting Oct. 12-15

Chicago, Ill.—Chicago's Hotel Sherman again will house the annual convention of the U. S. Independent Telephone Ass'n, according to an announcement made by C. C. Deering, secretary of the association. The dates set for the convention are October 12-15.

C. M. Kelly Named by Graybar for New England

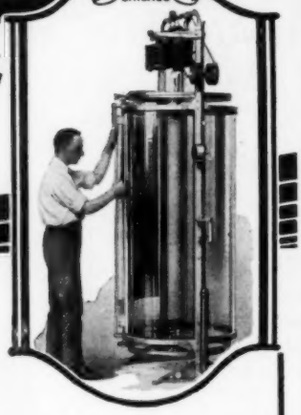
New York City.—Graybar Electric Co. has appointed Charles M. Kelly district sales development specialist for New England territory, with headquarters at Boston. Mr. Kelly will be in charge of all engineering work in connection with the sale and installation of public address equipment and other applications of electrical amplification apparatus.

Tri-State Figures for 1925

St. Paul, Minn.—The annual report of The Tri-State Telephone and Telegraph Company shows that the company now has over 100,000 stations and a gross revenue slightly in excess of five and a quarter millions of dollars. Since 1921 the gross revenue has increased from $4,150,877 to $5,272,985. Telephone operating expenses amounted to $3,327,280 and net telephone operating income was $1,838,040. After adding non-operating income and deducting rents, taxes and interest charges the net income available for distribution was $1,077,009, an increase of 11.35 per cent over 1924. Dividends of $749,135 were paid and $327,874 was carried to surplus. The company has adopted the continuing five-year program as a basis for its annual budget, and the directors anticipate an expenditure of $1,572,300 for extensions and betterments in 1926. It is probable that no new financing of any magnitude will be required in 1926.

PEASE CHICAGO

FASTEST VERTICAL BLUE PRINTING MACHINE



The Pease Vertical Blue Printing machine will turn out a steady supply of perfect blue prints whenever you want them regardless of weather conditions, at a faster rate of speed than is possible with any other equipment of its type.

Absolutely noiseless in operation, the Pease Vertical can be placed in one corner of your drafting room. So rigidly constructed that it can be shipped anywhere completely assembled without danger of breakage. Prints on either direct or alternating current.

New Pamphlet
"Instructions for Making Blueprints"

Write for your copy of this pamphlet. Tells the complete story of the Pease Vertical and shows how to make perfect blue prints—no obligation.

The C. F. Pease Company
807 N. Franklin St., Chicago, Ill.

PEASE
BLUE PRINTING MACHINERY
LET BLUE PRINTS TELL YOUR STORY

AVENARIUS
TRADE MARK
CARBOLINEUM
MADE IN U. S. A.

Shake! We're having our fiftieth birthday, too

Avenarius Carbolineum Wood Preserver and the telephone were born the same year. We grew up together. As the growing telephone industry demanded more and better poles it realized its wisest pole purchase was that with the long life and lasting strength assured by Avenarius Carbolineum treatment.

In fifty years pole preservation has grown tremendously. Untreated poles for any responsible use today are condemned by technical and economic opinion. Always in the lead among preservatives and stronger in authoritative preference today than ever before, is Avenarius Carbolineum, the faithful, worthy companion of the telephone industry from its cradle days on.

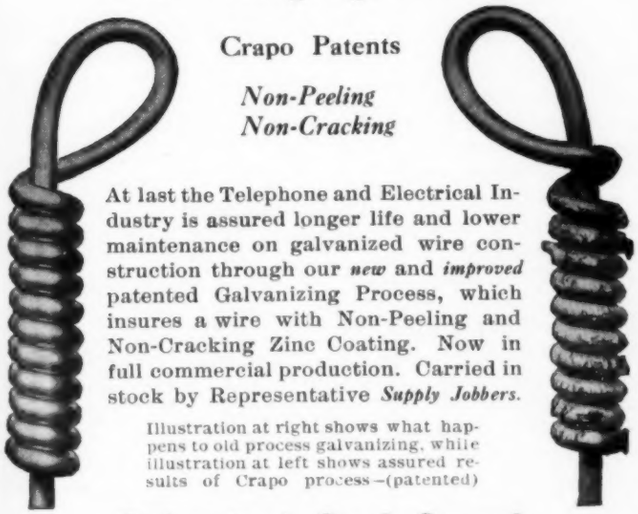
If you're not using Avenarius Carbolineum Wood Preserver, we'd better celebrate our jubilee years together by getting acquainted.

Write for the complete details of the Avenarius Carbolineum.

CARBOLINEUM
WOOD PRESERVING COMPANY
518-520 Prairie St. Milwaukee, Wis.

"INDIANA"

Double Galvanized Telephone and Telegraph Wire



Crapo Patents

Non-Peeling
Non-Cracking

At last the Telephone and Electrical Industry is assured longer life and lower maintenance on galvanized wire construction through our *new* and *improved* patented Galvanizing Process, which insures a wire with Non-Peeling and Non-Cracking Zinc Coating. Now in full commercial production. Carried in stock by Representative *Supply Jobbers.*

Illustration at right shows what happens to old process galvanizing, while illustration at left shows assured results of Crapo process—(patented)

Galvanized Steel Strand

Standard or Commercial, Siemens-Martin, High Strength and Extra High Strength Grades

Indiana Steel & Wire Co., Muncie, Ind.

"STAR-INSULATE"
Molded Composition
(Registered Trademark)

A New Marvelous Molding Compound

"STAR-INSULATE"

Receiver Cases
Mouthpieces
Ear Caps

Are Everlasting!

No other compound equals "Star-Insulate" in strength or finish.

Resilient—Unbreakable: Black or Semi-transparent: Anti-septic!

We mold all Models of Receiver Cases Mouthpieces.

GENERAL INSULATE CO.
1004 ATLANTIC AVE. BROOKLYN, N. Y.
Established 1904

"Sooners" Hold Big Joint Utility Meeting at Tulsa

By P. KERR HIGGINS

Tulsa, Okla.—Oklahoma is having wonderful success in co-ordinating the purposes and aims of the Public Service companies by bringing together the several divisions of this service in an annual convention. Each year shows a decided improvement and it was an inspiring sight to see more than six hundred delegates gather at the annual banquet on March 10 in the crystal ball room of the Hotel Mayo. This convention seems to grow bigger and better each year and the officers deserve great credit for the pep and enthusiasm which they have instilled in the membership. They seem to believe firmly in one of the favorite quotations of the star speaker at this meeting, Mr. Douglas Malloch of Chicago, Ill., which reads:

"If you can't be the highway, then just
be the trail,
If you can't be the sun be a star;
For it isn't by size that you win or you
fail—
Be the best of whatever you are!"

Mr. Malloch, who is a well-known columnist and poet, kept the banqueters not only deeply interested, but in a merry mood throughout his witty lecture on "Husbands and Wives." The Insulators Glee Club also rendered some excellent selections during the banquet. The Southwestern Bell Telephone Company gave a ball in honor of the Golden Jubilee of the invention of the telephone and the ball room was entirely filled with public utility men and women.

The telephone program was quite good, but like the marriage feast at Cana of Gallilee, the best was served up last, when most of the delegates had left for their homes. Miss Barnes conducted a fine operating school and Mr. Gustavson of Fredonia, Kans., Mr. L. W. Scherer of Yale, Okla., and others gave fine demonstrations of the use of radio in conjunction with telephone business and the instruction was quite interesting and helpful.

This year the registration was over eight hundred against six hundred and sixty last year. All of the division meetings were well attended.

Earl Jennings, transmission engineer, and his assistant, Mr. Ralston, of the Bell Telephone Company, Oklahoma City, gave an exceedingly interesting and instructive lecture and practical demonstration of the many difficulties found in maintaining a high degree of transmission efficiency in telephone work. The writer was much interested in a tone testing set for magneto offices which was highly recommended by Mr. Jennings. As this set seems to be a necessary adjunct of any magneto telephone office and can be easily made up out of material on hand, I secured a copy of the circuit which is shown in Fig. 1.

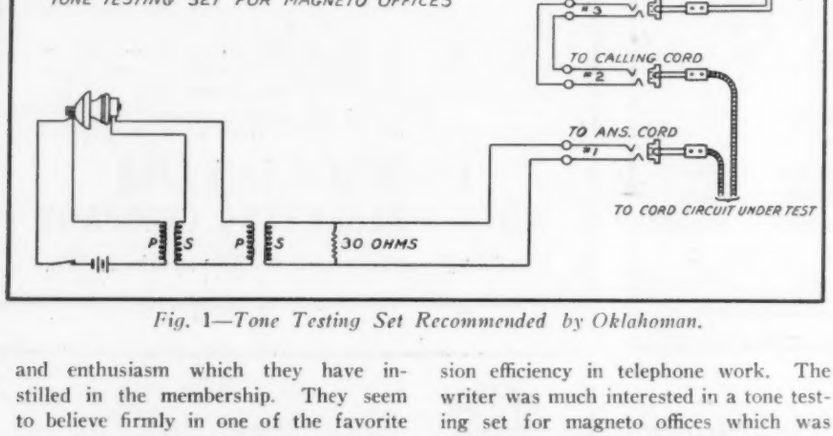
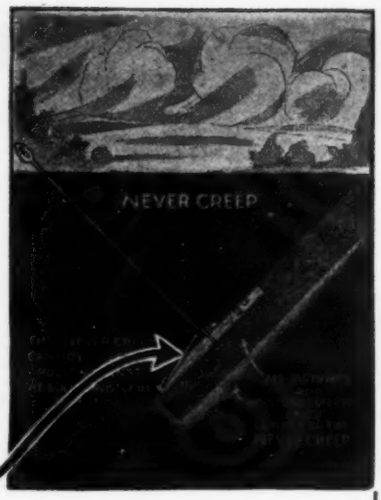


Fig. 1—Tone Testing Set Recommended by Oklahoman.

During and after the regular meetings of the convention the ladies were well entertained by hostesses under the leadership of Mrs. J. A. Whitlow. The telephone meetings were presided over by E. J. Boase of Frederick, Okla. The new officers of the association elected for next year are J. A. Frates, Tulsa, president; Major James H. Buell, Tulsa, first vice-president; L. W. Scherer, Yale, second vice-president; W. R. Emerson, Oklahoma City, treasurer; E. F. McKay, Oklahoma City, manager. New members on the executive board are: Electric Light Division, Major James H. Buell, Tulsa; Gas Division, R. C. Sharp, Tulsa; Electric Railway Division, J. A. Frates, Tulsa; Telephone Division, E. J. Boase, Frederick; Manufacturers and Suppliers' Division, E. B. Hathaway, Oklahoma City; Public Relations Division, R. S. McBeth, Tulsa. Messrs. E. F. McKay and F. W. Hubenthal are to be congratulated on the excellent work performed in the convention.



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Experiences With Common Battery Farm Lines

By C. W. KUGELMAN

About four years ago, it became necessary to replace a magneto switchboard with something more up to date. Much time was spent in deciding what would be best: A universal type board, or one with a universal position and two all-feature common battery positions. As the territory was building very rapidly and we were able to have continuous power, we decided on the latter type board and have not been dissatisfied with results.

The plan had some cable, also many lines from three to twenty miles long. After much careful checking and planning, it was decided to make as many of the lines as possible common battery, 5 and 10-party selective ringing. All lines previously were magneto, but several were operating 5-party selective.

As it was impossible to arrange all the lines for selective ringing as soon as they were cut over from magneto service, we went over all the telephones in the contemplated common battery territory, cutting condensers into the ringer circuits, instructing the subscribers not to use the generators when the new board should be cut in, and clearing the lines of bad joints, trees and all chances for leakage. How well this work was done showed up on the cut-over. With the large amount of twisted pair wire in use I was rather nervous when the time came to make the cut-over as I was afraid many permanent signals would come in. Forty-nine volts certainly shows up the weak spots. Something over 100 lines were cut to full C. B. selective ringing, in a few minutes, and much to my surprise only five permanent signals showed up. Of course, the longer lines—probably 300 stations—were cut into the magneto position which is lamp signal in place of drops. About 400 stations were made common battery.

All of the central office magneto equipment is of the universal type with convertible line circuits. Just as fast as we could make the changes more lines were cut over: Reversing jacks are used on all 10-party lines. This type of equipment, I believe, is far ahead of the old reversing key for selective ringing.

We were highly pleased with the action of the cord and line circuits as we were anticipating more or less trouble due to faulty lines. The plant was about twelve years old and had grown faster than we wanted, considering the size and roughness of the territory. Therefore, the lines had suffered somewhat from lack of proper maintenance. But, as before stated, we were very well satisfied with the results of the cut-over.

Common Battery Service Feasible if Power Is Available

Where a territory is supplied with constant power or lighting service, there is no real reason for maintaining a magneto system of any considerable size; especially, if adequate rates may be obtained for common battery service. The lower costs of common battery telephones, and their maintenance when compared to the costs of magneto sets, together with elimination of batteries in the latter type very nearly will offset any additional costs of common battery central office equipment.

Should one's plant require some magneto equipment on account of extra long lines, the equipment should be of the universal type in order that cord circuits may contain many features not obtainable or practical in straight magneto boards. With the universal equipment one may, by minor changes, cut the old magneto sets to common battery and still get many years of service out of them; or replace a few with common battery sets at once, using the replaced sets for new subscribers or replacements on the longer lines which have to be maintained magneto.

A great many magneto plants are in a more-or-less bad condition, due to being able to operate, to some extent, with poorly insulated or otherwise bad lines. While we all know that bad conditions should not exist, we also know they do exist in many localities. The magneto subscriber is entitled to just as good service as the one on the common battery plant.

By making your plant at least partly common battery, you will have to spend some money at first but you will save later, as a poorly maintained magneto plant is more expensive than a well maintained common battery one. Particularly so, if you do not consider the good will of your subscribers as one of your best assets.

Poor Lines Cause Prejudice Against Common Battery Service

Many no doubt will recall that several years ago some companies built long common battery farm lines of 14 iron wire, installing divided circuit sets. Switchboard signals were visual type, operating from 24 volts. For a time these lines operated fairly satisfactorily, with as many as 18 stations per line. As arresters were installed with each station, more or less trouble was experienced from lightning; carbons being of the soft type would ground lines very easily during almost any storm. These grounds were not always easy to locate, as some bells would ring and others nearby would not. As a condenser was used in sets whose bells rang from the wet side of the line, it was a rather difficult task, at times, to locate the grounds.

After about one year's time, subscribers had difficulty with transmission, so sets with local battery talking circuits were installed. This cleared up the transmission problem, but about the time all sets were changed, the lines began to show high resistance due to faulty joints and rusting wire. Investigations showed, at that time, that long common battery lines were not practical, so the instruments were changed to magneto sets similar to the type in use today. Divided circuit ringing, though never has been entirely abandoned, but in many cases has been replaced by harmonic bells, metallic ringing, also 8 and 10-party selective.

While the last two paragraphs have no direct bearing on present day common battery farm lines, they were given to show those who have lately taken up telephone work why there are not more long common battery lines. Many of us have been more or less bluffed out of trying them again.

Today, it is good practice to operate 24-volt common battery farm lines with not over 800 ohms loop resistance, or 8 or 10-party selective ringing. Of course, where one has 40 volts, much longer lines may be operated. But bear in mind that, if you install this service, you must have your lines clear of grounds and loose connections. You also must consider the transmitters as they are the one big factor in transmission.

Many present-day telephones have only one condenser, it being in both the secondary and ringer circuits. In order to eliminate leakage where the bells are cut to ground, another condenser (1 or 2 M.F.) must be cut into the ringer circuit, entirely replacing the former one, as regards the bell, for leakage prevention only. If this is not done, more or less battery will be shunted to ground and transmission will be poor; especially when two parties are talking on the same line, or when the eavesdropper comes

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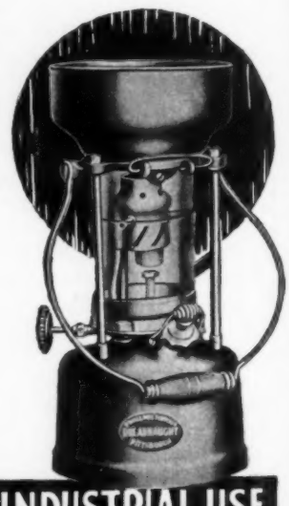

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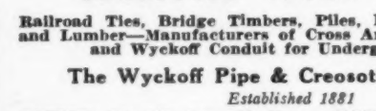

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on the line. It is not absolutely necessary to have a break contact in the ringer circuit to the hookswitch as the bells, where the receivers are on the hook, are on one side of the line to ground anyway. Only the telephone in use would have its bells clear from the line.

Ten-Party Service Is Feasible

I do not know how many are using five frequencies in ringing, that is 30-42-54-66 and 16 or 20 cycles, but I do know that it is a satisfactory way of operating 10-party lines several miles in length. The older type frequencies, 33⅓, 50, 66⅔ and 16⅔, which allow 8-party selective has been giving good satisfaction for several months. The 4 and 5-party selective are, of course, being operated metallic.

On our system, all circuits having divided ringing have a Cook No. 2 arrester installed with each instrument; no fuses. There are many different ideas regarding arresters. I can speak only from past experience with other types and I have come to the conclusion that the carbon block meets the requirements.

As our main exchange is growing very fast, we figured for quite a while as to just how to number the 8-party lines and where to place the jacks in order to not disturb the standard multiple lay-out. Finally, we decided, as there were to be 40 lines to start with, to mount the answering jack directly following the standard answering jack lay-out and to mount the multiple jacks in the space about 1,000 lines ahead of the present multiple. This allows a growth of 1,000 future lines and throws future answering jacks one position ahead; this does not materially interfere with the standard growth. Further, should the 40 lines be filled to capacity, one operator might not be able to handle them; therefore, with the scheme used, she will have help from either side or can help others should occasion require. This is impossible with a magneto position.

As the numbering scheme was next in line, quite a bit of thinking was required on that subject, as the local lines were up to the 3,500s and the magneto numbers picked up with 3,600. To avoid getting into a word prefix or five figures, we made the prefix 0, using the scheme 0101—0102, etc., up to and including 0139 for the tip side, and 0140—0141, etc., for the ring—or, in our case, 2-wire multiple, sleeve side. From the first strip of multiple, the cables are run to the intermediate frame, all reversing being done there.

As two spaces are between the top of the 0120—0139 strip and the 0140—0159 strip, there is no danger of the operator ringing on the wrong side of the called line. Should a party call for a party on the same or opposite side of the line, a distinctive revertive tone notifies the operator that the party calling wants some one on the same line. She then has the party calling, hang up for the ring. As this kind of a call seldom comes in most of the operators probably do not know what jacks are associated, the ordinary busy test is always on when any of the lines are busy.

I believe any plant will be fully justified in cutting as many long lines as possible to common battery selective ringing, thus doing away with trunking to magneto positions; also, depending on probably one operator answering quickly, and properly supervising magneto subscribers.

If your territory is large, leads heavy and lines long, you will find money well spent if invested in 19 or 20-gauge cable (preferably 19) and frequent terminals cut in to care for your rural subscribers, thus giving them practically city service.

Harrison, French Battery Executive, Stars as Industrial Producer

G. Charter Harrison, who was elected to the directorate and appointed vice-president at the last directors' meeting of the French Battery Company in Madison, Wis., brings to his new work an ability and experience equalled by few executives in modern American business. The action of the board was taken as a recognition of Mr. Harrison's outstanding achievements as general sales manager of this corporation since he joined their forces last fall.

G. Charter Harrison

Reports of the greatest gross business in the eight months of Mr. Harrison's incumbency, with monthly sales records far surpassing those of similar periods in other years, are reflections of previously demonstrated success with the National Cash Register Company, Rolls Royce, Ltd., American Rolling Mill Company, the reorganization of the old N. Rumely Company, now the Advance Rumely Company, the installation of modern methods of cost accounting and cost systems for the International Silver Company, American Thread Company, Hayes Wheel Company, Chase Bag Company and others of like calibre, in addition to a successful career as a partner in the London firm of chartered accountants and industrial engineers of Baker, Sutton and Harrison that was dissolved because of conditions brought on by the World War in May, 1918.

"Who's Who in Engineering," 1922-3, provides this interesting data on Mr. Harrison:

"Originator of scientific methods of cost predetermination, representing application of scientific management principles in cost accounting; also developed scientific co-ordinated cost, planning and production methods; introduced his methods in some of largest industrial establishments in country; author, "Cost Accounting to Aid Production" (series of nine articles in Industrial Management Magazine, 1918-1919); also book, same title, 1920. Asso. mem. A. S. M. E.; asso. Inst. Chartered Accountants of England and Wales; mem. Am. Econ. Assn. Recreations, motoring, photography. Club, Railroad (New York)."

Through an arrangement with J. B. Ramsay, president, and the directors of the French Battery Company, Mr. Harrison is retaining his interest in the firm of Stevenson, Harrison & Jordan, prominent New York industrial engineers.

More Construction Is Planned for 1926

The Lanier Telephone Exchange, of Hartford, Ala., W. M. Lanier, Mgr., expects to put in 20 miles of No. 10 B. & S. copper wire this season and make some general repairs. In the market for copper wire.

The Rural Telephone Co., of Knox, Pa., H. K. Dietterick, Mgr., will want line materials for the general repairs it contemplates.

The Wautoma-Mt. Morris Farmers Telephone Co., of Wautoma, Wis.; L. H. Larsen, Sec., is in the market for wire, cross arms, braces, bolts, insulators and pins. Three additional circuits to Silver Lake are to be built.

Any telephone book published may be bought from TELEPHONE ENGINEER.

Max Hosea Heads Merger of Indiana Properties

Indianapolis, Ind.—Max F. Hosea, one of the leading Independents of Indiana, is a prime mover in a merger of seven Indiana companies under the banner of the United Telephone Co. The seven properties to be merged are the LaGro-Andrews Telephone Co., J. C. Eckhart Telephone Co., Burlington Telephone Co., Kirklin Telephone Co., Matthews Telephone Co., Summittville Telephone Co., and Citizens Telephone Co. Other incorporators of the company are S. R. Brewer, W. M. Turner and Harley and Ernest Hodson.

Holliday Resigns as Sec.-Treas. at Jacksonville, Ill.

Jacksonville, Ill.—W. W. Holliday, for 20 years associated with the Illinois Telephone Co., has resigned as secretary and treasurer of the company. Mr. Holliday will remain with the company as head of the Jacksonville exchange, where he formerly served as manager. The veteran's 72 years have been rich in achievement and he now feels that he can spend the rest of his time without being under the pressure of his numerous interests.

P. M. McCullough Named Mexico International Engineer

Mexico City, Mex.—Philip N. McCullough, formerly outside plant engineer for the Nebraska division of the Northwestern Bell, has become chief engineer for the International Telephone and Telegraph Co. in Mexico, the company controlling the Mexican Telephone and Telegraph Co. Capt. McCullough is a native of Nebraska and has had considerable military experience as well as a splendid career in the telephone industry.

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Stromberg No. 681 C. B. straight line desk set with steel signal set @	7.00
Stromberg No. 428 type C. B. Desk set with straight line wood signal set @	6.50
Kellogg No. 2805 3-bar 1000 or 1600 ohm bdg. hotel sets @	6.75
Western Elec. No. 305 3-bar 2500 ohm Bdg. hotel sets @	6.50
Chicago Tel. Supply Co., 4-bar 1000 or 1600 ohm Bdg. compacts @ $6.75—5-bar @	7.25
Am. Elec. No. 360 Pony type 3-bar 1000 or 1600 ohm Bdg. compacts @ $7.00—4-bar @ $7.50—5-bar @	8.25
Monarch 4-bar 1000 or 1600 ohm Bdg. compacts @	7.25
Weston Model No. 264 Mil-Ammeter—Scale reading 0 to 30 or 0 to 50 or 0 to 150 Mil-Amp. @	5.00
Weston Model No. 54 Volt Meter Scale 0 to 70 volts @	7.00
Weston Model No. 269 Am.-Meter Scale 0 to 30 Amps. @	5.00
Queen-Acme Portable Wheatstone Bridge @	35.00
Western Elec. Co., 8 drop Annunciator @	4.00
Dixie 3-Drop Annunciator @	1.50
Cook No. 14 Arresters, per bank of 20 lines @	6.50
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Texas Body Attains Majority at Big Annual Convention

Fort Worth, Tex.—Texas celebrated the fiftieth year of the telephone and the coming of age of its own Independent Telephone association by staging the liveliest convention in the annals of the Lone Star state's telephone industry. Attendance reached a new high and a great array of practical papers, spirited discussions and well displayed exhibits gave the Texans good payment for the time they spent at Fort Worth.

Headed by R. B. Still of Tyler, the entire roster of officers was re-elected to continue their splendid program.

Nearly 300,000 stations and several thousand miles of long distance lines are owned by the members of the Texas association now, remarked Mr. Still in his presidential address. He cited specific instances of the association's team-work with its members in bringing about the great growth experienced during the past several years by the Texas Independents. District meetings have been the regular order in Texas for some time past. At these district meetings telephone men and women from 137 points in the state have been present.

The trend toward mergers is being felt in the telephone business the same as in other industries, commented the Texas chief, in forecasting that there would be fewer telephone companies during the years to come. This does not mean, he said, that there would be any retirement of the able men now engaged in the business, but union of properties so the financing position would be strengthened. Such combinations, according to Still, were the only possible practical avenues to financing. He strongly warned the smaller companies against the offer of certain "grafters to sell your securities and secure cheap money."

There is a bright picture for the financing of the larger Independent companies, Still told the convention. He strongly advised his hearers to build up their plants every year in both outside and inside construction, but not to attempt to cover more territory than they could properly maintain and finance.

Blomeyer on Management

E. C. Blomeyer, vice president of Theodore Gary & Co., in speaking on "Money, Marbles and Chalk," said that the foremost problem of the Independent industry today is financing and continuity of management. Companies with a good earning record, but unable to give assurance that profits will be continued without the same management being continued in office, are out of luck due to their lack of foresight in training men competent to continue the successful policies now in effect. On the subject of mergers Blomeyer said that three companies losing money could not be merged into one profitable company, and advised against ill-considered and hasty combinations. He commented on the Texans' good fortune in being immune to the storms that totally destroy northern companies in a few hours' time.

The financial aspect of telephone work came in for a lot of high-powered treatment. Charles Deering, national secretary, spoke on uniform accounting, and W. R. Compton, Jr., of W. R. Compton & Co., St. Louis, addressed the meeting on "Independent Telephone Financing and the Investment House," presenting a clear picture of the operations. He said the cost of handling a bond issue for a very small Independent telephone company would be not only prohibitive but practically suicidal.

A proposal to draft a code of ethics for the association's members followed the talk of George W. Briggs, vice president of the City National Bank of Dallas, on "A New Concept of Business."

Plant accounting received some expert clinical treatment at the hands of a number of experienced Texas telephone men. The accounting conference was presided over by E. J. Hardgrave of San Angelo, and opened with the address of L. S. Gardner on "The Why of Plant Accounting." Featured speakers at this conference and their subjects:

"Handling Realized Depreciation," discussion led by John W. Pace, Haskell, general manager, Haskell Telephone Co.

"What *Is* and *Is Not* Chargeable to Plant Construction Accounts," discussion led by several present.

"How to Differentiate between Maintenance and Replacement," discussion led by R. B. Still, Tyler, general manager, Gulf States Telephone Co.

"What Is Proper Accounting When Plant and Equipment Is Retired," a discussion led by F. W. Greber, Brownwood, vice-president and general manager, West Texas Telephone Co.

"The Effect of Erroneous Charges to Plant Instead of Maintenance Accounts," discussion led by E. J. Hardgrave, auditor, San Angelo Telephone Co.

"Proportionment of Overhead Expense to Construction, Reconstruction, and Maintenance," discussion led by J. C. Paxton, McAllen, general manager, Rio Grande Valley Telephone Co.

"Distribution of Automobile and Tool Expense to Construction and Reconstruction," discussion led by E. C. Thomsen, Waco, plant accountant, The Texas Telephone Co.

A revenue and general accounting conference was held with L. S. Gardner at the helm. Charles Milliger, Llano, launched the session with a general and "close up" talk on telephone accounting. Specific details of telephone accounting were handled during the session, as follows:

"Importance of Keeping an Accurate Subscribers' Ledger and Balancing Monthly," discussion led by C. W. Jacobs, Tyler, auditor, Gulf States Telephone Co.

"A Voucher System for Small Companies," discussion led by Merton Swift, San Marcos, general manager, San Marcos Telephone Co.

"Subscribers' Rental and Toll Billing," discussion led by L. S. Gardner, Waco, auditor, Texas Long Distance Telephone Co.

"The Balance Sheet and What It Represents," discussion led by Fred M. Moore, Waco, auditor, The Texas Telephone Co.

Big Traffic Conference

One of the big features of the meeting was the traffic conference, during which the executives and operators joined forces in working toward a solution of their common problems. Approximately 150 operators sat in on the sessions, which were run by a committee composed of Sam H. Shutt, Waco, general superintendent, Texas Long Distance Telephone Co.; Oscar Burton, Tyler, assistant general manager, Gulf States Telephone Co., and Earl R. Evans, Waco, traffic superintendent, The Texas Telephone Co.

Miss Anne Barnes, special representative of the national association, was a headliner with her address on "Small Office Operating." H. M. Cox of Waco spoke on "How Toll Operating Appears to the Commercial Department." "Forty Essentials of Toll Operating Practice" was a symposium featuring eight toll chief operators. George McQuaid, director of the Texas Public Service Information Bureau, spoke on "Telephone Service from the Subscribers' Viewpoint."

Earl R. Evans, Waco, presided over the final session of the traffic conference, which featured F. W. Greber, Brownwood, on "Obligations of Managers and Owners to Traffic Department."

The exhibitors, represented by Frank Eldridge of the French Battery Co., extended a vote of thanks to the association for its handling of the exhibition end of the meeting.

A big luncheon which presented a historical pageant of the telephone was the high spot of the entertainment part of the convention. Alexander Russell, at present editor of the Galveston Tribune, who installed the first telephone in Texas three years after the Bell patents were granted, gave some highly interesting reminiscences.

C. D. McClary Is New Graybar Sales Manager at Philadelphia

Philadelphia, Pa.—Promotion of C. D. McClary to sales manager of the Philadelphia distributing branch has been announced by the Graybar Electric Company. Previous to his new appointment, Mr. McClary was manager of the Pittsburgh distributing branch of this company.

Shirley (Ind.) Company Changes Hands

Shirley, Ind.—W. W. Thomas, Whitestown, Ind., has bought the Shirley Telephone Co. from L. L. Christney. The property will be improved by its new owner.

International Spurs Czecho-Slovakian Extensions

New York City—Another indication of the progress being made in the installation of facilities for telephonic communication between the important cities of Europe is the completion by the Czechoslovak Telegraph Administration of a telephone cable between Prague and Kolin. The cable is of the lead covered armored type, 58.7 km. in length, and, according to the plans of the administration, will be extended to Bratislava to take care of the long distance telephone traffic between the Czech and Slovak capitals.

Repeaters have been installed at Prague and Kolin to link up the cable with the existing open wire network. The repeater equipment was furnished by the Bell Telephone Manufacturing Company, Antwerp. Loading coils and cases for the entire project were furnished by Standard Telephones and Cables, London. Both of these concerns are associated companies of the International Standard Electric Corporation.

The long distance company was formed to assist in carrying out this project and represented the Czechoslovak Administration, the Czechoslovak cable manufacturers located at Bodenbach and Bratislava, and the International Standard Electric Corporation. The cable contains 44 quads of 1.3 mm. conductors and 32 quads of 0.9 mm. conductors, and was manufactured, installed and tested under the supervision of engineers furnished by the International Standard Electric Corporation in accordance with "International Standard" methods. An order for the second section of this cable connecting Kolin and Jihlava, a distance of 84 km., has been placed recently by the Czechoslovak Administration. The cable will be equipped with "International Standard" loading coils and repeaters. In addition to the repeaters at Prague and Kolin, a repeater station will be erected at Jihlava.

J. F. Davis New Pittsburgh Graybar Manager

Pittsburgh, Pa.—J. F. Davis has been made manager of the Pittsburgh distributing branch of the Graybar Electric Company. Previous to his appointment, Mr. Davis was sales manager of the New York distributing house of this company.

A corner in the Runzel-Lenz testing laboratory.

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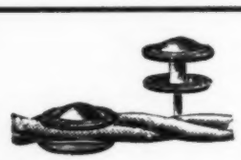

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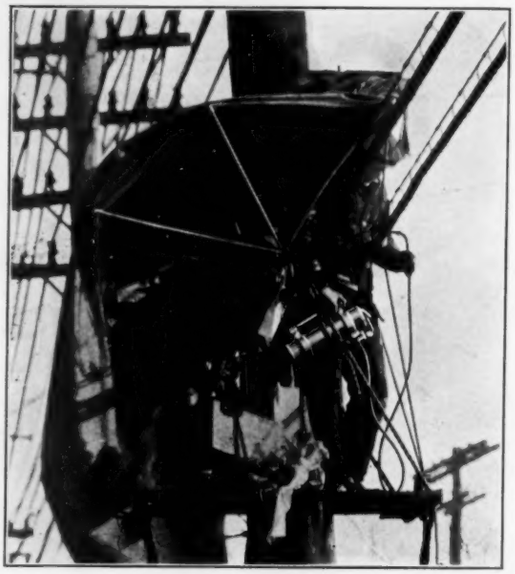

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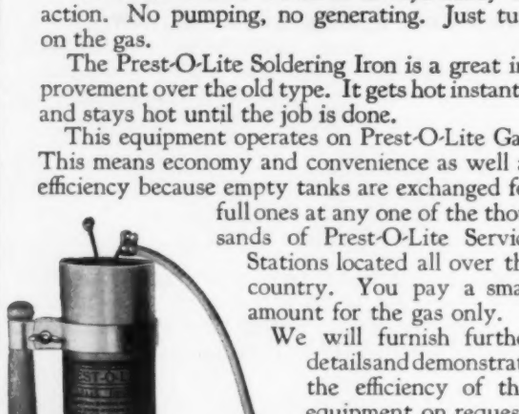

Illustration shows the portable size for pole work

Prest-O-Lite Gas

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